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The Fishery Harbors of Scotland.

By JOHN TAYLOR,* Assoc. M. Can. Soc. C. E.

The following paper contains some of the writer's personal observations and notes, obtained while engaged, for several years, on the design and construction of improvement works, of various kinds, in connection with several of the leading fishery harbors of Scotland.

The history of the development of these fishery ports is inseparably bound up with that of the progress of the fishing industry in the British Isles. As Great Britain depends, to such a great extent, on exterior sources for her food supply, the ability to draw on the surrounding seas, for an additional home supply, has led the Government to advance funds where necessary at low rates of interest, for the provision of shore works and harbors, to accommodate the growing fleets of vessels, engaged in the work. This food supply, if carefully husbanded, will provide an almost inexhaustible source and storehouse of wholesome food, for the industrial population of the country.

According to the latest report of the Fishery Board of Scotland, the number of persons engaged in the work in Scotland is 92,359, while the number of vessels is 10,078. This will give an idea of the proportions to which the business has grown. It is now more prosperous than ever and with the use of modern improved appliances must progress still further. The present total value of the Scotch fish supply is about $15,000,000 per annum.

FIG. 1. VIEW OF ONE OF THE FISHERY HARBORS AT BUCKIE ON THE NORTHEAST COAST OF SCOTLAND.

Perhaps a few historical notes, dealing with the industry, will prove interesting to the reader.

History of the Industry.

Nowadays around the coast of Scotland, but principally on the east and north coasts are to be found dotted at irregular intervals of a few miles, sometimes close together and sometimes wider apart, communities of hardy fishermen, who obtain their livelihood from the finny deep. These men are for the most part the descendants of Norse, Danish and Saxon forefathers, who felt the call of the west, even in those early days, and crossed the North Sea to the new land in their small sailing craft to seek a new home. Bringing their wives and families with them these early Vikings settled along the coast of Scotland. The sea provided the principal source of their food supply, and now after all these centuries one finds there the descendants of those early pirates and rovers. The conditions are changed, it is true; instead of rude hovels and frail little open boats, we now find neat houses and villages, large deck boats driven by gasoline engines and sails, and steel steam propelled drifters and trawlers, with harbors for the most part now built of that most up-to-date of building materials, Portland cement concrete. The men, however, still possess the same characteristics and independent spirit. As in the old days they were looked upon as intruders by the native Celt, who lived inland and did not mix with them, so even yet they form a class of people by themselves, who intermarry and remain isolated to a great extent from the other classes, and still retain their attachment to Father Neptune.

When their forefathers settled on the usually rather inhospitable coast, they generally chose a spot which provided a sheltered place to beach their little craft. Here they built their small houses of boulders and clay, the roof covered with thatch, and caught their fish, selling or exchanging what they could to the people further inland, and so helping to add to their somewhat precarious livelihood.

These early settlements were sometimes at the mouth of a river, or in a sheltered bay. Often they were on the open coast at a point where the boats could be run ashore on a sandy beach partly sheltered perhaps behind a reef of rocks, which formed a natural breakwater. These small struggling communities gradually grew, surviving all the social and political troubles undergone by Scotland, and the struggle with nature.

Some of the more progressive of them improved on the accommodation provided by nature, and built themselves small sheltering breakwaters of rough boulders to check the surf from reaching their landing beach, and thus provided a calm spot to launch and beach their boats. Then clearing their strip of beach of loose boulders, they would perhaps erect a rough imitation of a landing place, thus forming the nucleus of the modern fishery harbor. As their wealth increased and their vessels grew in size, the small ports were extended. Thus the evolution of the now famous modern North Sea fisherman and his social condition progressed. As time went on the necessary works got beyond the building skill of the fishermen whose forte was more in sailing a boat in the teeth of a gale.

Engineers had to be called in to design the harbors and superintend their construction. Some of the earlier works, still existent, are generally constructed of large masonry blocks built dry and securely bonded. Most of their more ambitious attempts constructed in this way show signs, by the presence of iron straps and bolts in the masonry, of their difficulty in holding the blocks in position. The great care and skill with which some of them were built is evidenced by their present state of preservation, even though now neglected or abandoned. The writer has noted several of these early works and has observed that often their first signs of general collapse show at the inner ends of the piers where the foundations get eroded at the junction with the land. This is often a weak point in larger structures. This is of course apart from cases of failure, caused by decay of the stone, or by the weathering action of the waves. The engineers called in have labored with varying degrees of success often handicapped by a lack of funds. Father Neptune seems to view with contempt

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the audacious efforts of man to encroach on his domain and he who would have his structures stand the test of the continual battering they receive must build both wisely and well.

When the fishing boats had become too large to beach with safety, it became necessary to have sheltered areas enclosed, with sufficient depth of water to at least float the vessels at high water. Choosing their time to return from the fishing grounds, the boats entered the little harbor at high tide, discharged their catch, and allowed their vessels to ground on the soft bottom of the basin at low tide. Sometimes they would remain in port for a day or two, but more generally during the fishing season they would refit and hurry away to sea again on the next high tide.

After a time this method also became unsatisfactory. With larger boats and the greater amount of capital necessary to fit them out, the owner naturally wished to enter and leave port at all states of the tide. The delay in unloading the catch, caused by waiting for the tide to rise, seriously impaired the market value of the fish. Unfortunately for the fishermen, accommodation for their boats is costly and difficult to construct and maintain. About this time, however, the use of cement concrete began to be understood, and thus supplied a cheap construction material. In most of the work of this class carried out during the last thirty or forty years cement concrete has been used to a large extent. It is safe to say that many of these harbor works would never have been built but by its use. The design, construction and subsequent behavior of the harbors constructed by the aid of this comparatively new building medium, at least as we now know it, forms an interesting study both to the harbor engineer and the concrete specialist. Although not generally of a very elaborate or large class, these works by reason of their great diversity of situation and design are capable of giving lessons in detail which a large work might not possess. The tidal currents, exposure, geological formation and geographical form of each site varies and each structure must be built to take the best advantage of local conditions and adapt it to the peculiarities of the site. A close and intelligent study of the laws of nature and local conditions is necessary to attain success in their design.

General Design.

To build a harbor on the exposed coast is no child's play, and especially so with a new material, then in the experimental stage, as was concrete. Although partial failures have occurred from a variety of causes, the resulting success has justified its use. The initial cost was low, a vital point in these works and although damage has been done to some of the work, this has not been abnormal or more than one would reasonably expect, considering the hard life of the structures. In order to get a sufficiently large enclosed area it was necessary in the design to choose between building the harbor close inshore and excavating the basin from the beach, or building massive walls out into and enclosing deep water. The former method required less costly piers as the water was shallower, but the excavation was costly. In addition it generally gave an entrance which was difficult to navigate, being too close inshore for safety and it also increased the danger from silting. The latter course has generally been adopted, although we sometimes find a combination of both. Only a few of these ports possess naturally protected harbors.

The early attempts were financed and built by the fishermen themselves, but it proved beyond their capacity to raise funds to build work of a costly description in the open sea. To meet this want and to foster the fishing industry, the Government came to their assistance with low interest government loans. When a scheme is proposed, the Government holds an enquiry and when satisfied as to the merits and needs of the work it advances a large percentage of the total outlay, the local authorities being expected to contribute the balance to the finances of the scheme. Unfortunately for the engineer, many of the fishing villages are too small to justify any very large expenditure and as each village wishes to have a harbor of some sort of its own, instead of combining their efforts and erecting large central harbors, the result has been a large number of little ports small in water area in proportion to the expenditure. Although the enclosed water area is small, the piers and breakwaters have to be made as heavy in section as those enclosing a large area, consequently the cost is proportionately very much higher per unit of area making allowance for the greater depth generally necessary in large works.

Another point which renders a greater expenditure necessary per unit area enclosed is that the length of the piers is proportionately greater in the smaller work. For instance to enclose one acre on three sides requires piers 236 yds. long measured on the center line, while to enclose 20 acres requires 960 yds., the disproportion becoming greater as the area increases. Area to length in the smaller work is as 1 to 236 while in the larger it is as 1 is to 48. The chief difficulty preventing concentration has been a social one, as the fishermen cling to their own villages tenaciously. Now, however, the problem is solving itself along competitive commercial lines. The smaller places are falling behind in the race, on account of lack of funds to provide the increased accommodation necessary, so that the boats concentrate at the leading ports during the fishing season, though the fisherman's families remain at home in the smaller villages. Even in the now practically abandoned smaller harbors which are now chiefly used for storing boats, much of the work carried out is of interest to the harbor designer, for the engineer was expected to combine in a small harbor, with scanty funds, all the good points of a larger harbor with plenty of available cash. To obtain all these good points was, of course, an obvious impossibility.

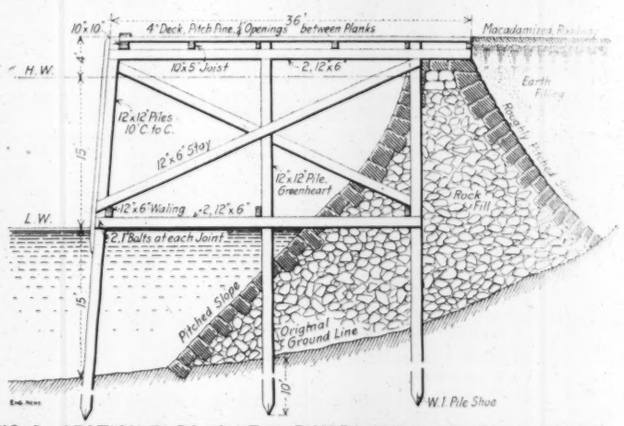


FIG. 2. SECTION THROUGH THE TIMBER AND MASONRY QUAY WALL AT STORNOWAY HARBOR.

The chief Scotch ports following round the coast are Stornoway, Lerdick and Balta Sound in the Shetland Isles, Stromness in the Orkney Isles, Wick, Buckie, Macduff, Fraserburgh, Peterhead and Aberdeen, besides others of less importance. These ports have been provided to varying degrees with well sheltered harbors, fish markets and either a good steamer connection or train service, to the southern industrial markets. When the fish are landed at the various ports they are sold to wholesale fish buyers, who pack and consign the fish to market. Naturally the fishermen frequent the ports where the greatest number of buyers are to be found, which is, of course, at the larger harbors.

Unfortunately, signs are already apparent of capitalistic control of fishing fleets, which is a state of things to be deplored in comparison with the privately owned boats, where each man had a share in the vessel and profits. If capital gains control it will relegate this fine hardy race of men to the position of wage-earners, with a corresponding loss of independence. So far capital has confined its attention chiefly to whitefish trawling. These trawlers are steel steam-propelled vessels costing about $30,000 and capable of a 15-knot speed. The ordinary modern herring fishing boats of the "Zulu type" are built of wood and cost about $6,000 with their equipment. The fishing boats use sails and some are fitted with gasoline motors to propel them in a calm or against a head wind. The new type of steel drifters cost $15,000 each. In the trawling method of whitefishing, the fish are caught by a strong bag-like net dragged through the water by the vessels which steam ahead. The nets are lifted aboard at intervals by steam power and emptied of the fish on the deck. The contents of the net are sometimes varied as the net catches everything that comes in its way.

The herring fishing boats carry hundreds of yards of net, which are set in lines in the open sea and kept afloat by buoys attached to one side of them. A shoal of herrings coming along, and failing to get past the net, try to go through and get caught in the meshes of the net. Sometimes in such numbers that the whole catch is lost. Larger fish, like cod, are caught by means of hooks by the fishermen. It is asserted that the trawlers, though perhaps more effective are wasteful of fish life and that they have at least partially denuded some of the older fishing grounds. The Government maintains several small fishery cruisers to patrol the coasts and enforce protection laws. Hatcheries for the artificial propagation of fish spawn have been established around the coast with excellent results.

Most of the fish catch is consumed in the British Isles, but a considerable amount particularly of the herring, are packed in barrels preserved in brine and shipped to Europe, particularly to Hamburg.

Some of the fishery harbors, particularly those on the west coast, are situated in natural bays, which require no expenditure on breakwaters for protection from seas. Timber or other piers projecting from the shore of the bay into sufficiently deep water are sometimes all that is necessary. In the greater majority of cases, however, on the north and east coast the harbors are built on the open sea coast so that costly protection works are necessary. In fact in some of the smaller ports nearly all the work carried out consists of sheltering piers behind which the boats lie. Many of them have an outer and inner basin, the former being chiefly of value as a spending beach for waves entering the harbor and being commercially of little use except in calm weather.

Detailed Description of Various Harbors.

The various ports dealt with and described have been chosen as fairly representative examples of the many works of this class.

CASTLEBAY.—This is situated on the small island of Barra at the southern end of the outer Hebrides off the west coast of Scotland. Here the fishing boats resort at the beginning of the fishing season in May. It is a straggling little village but possesses an excellent natural harbor in a deep sheltered bay on the southeast side of the island protected from the Atlantic. The fish catch of this and the other island ports is transported by steamers to the mainland. All around the bay, which has deep water close inshore, the fish-curers have erected small timber landing piers, for unloading the boats, with their fish-curing sheds on shore.

The port has also a steamer pier constructed of greenheart piles which resist the teredo, the superstructure above the water line being built of creosoted pitch pine. The greenheart timber in this and several other steamer piers on the west coast of Scotland has been in position for

about thirty years and it is now in as good condition as ever, with the exception, of course, of ordinary traffic tear and wear, so that it has successfully fulfilled the purpose for which it was intended. The teredo avoids this timber like the plague, but will after a number of years attack treated pitch pine in which the creosote has lost its strength by immersion in sea water. This only happens, however, after quite a number of years. Ordinary untreated pitch pine immersed in sea water, will become in some cases hopelessly damaged by this marine borer in five years, or even less. As greenheart timber in Britain costs about three times the price of pitch pine, the question, of course, arises in its use whether it is not better to use the cheaper timber treated with creosote and reconstruct it after the creosote has lost its preserving power and the teredo has eaten it up. Greenheart timber seems to possess almost never ending life, while reconstruction obstructs traffic and is costly, so that it is a question of financial economy. Perhaps a compromise with greenheart piles and creosoted pitch pine for above water work is the best solution, as it combines the advantages of both.

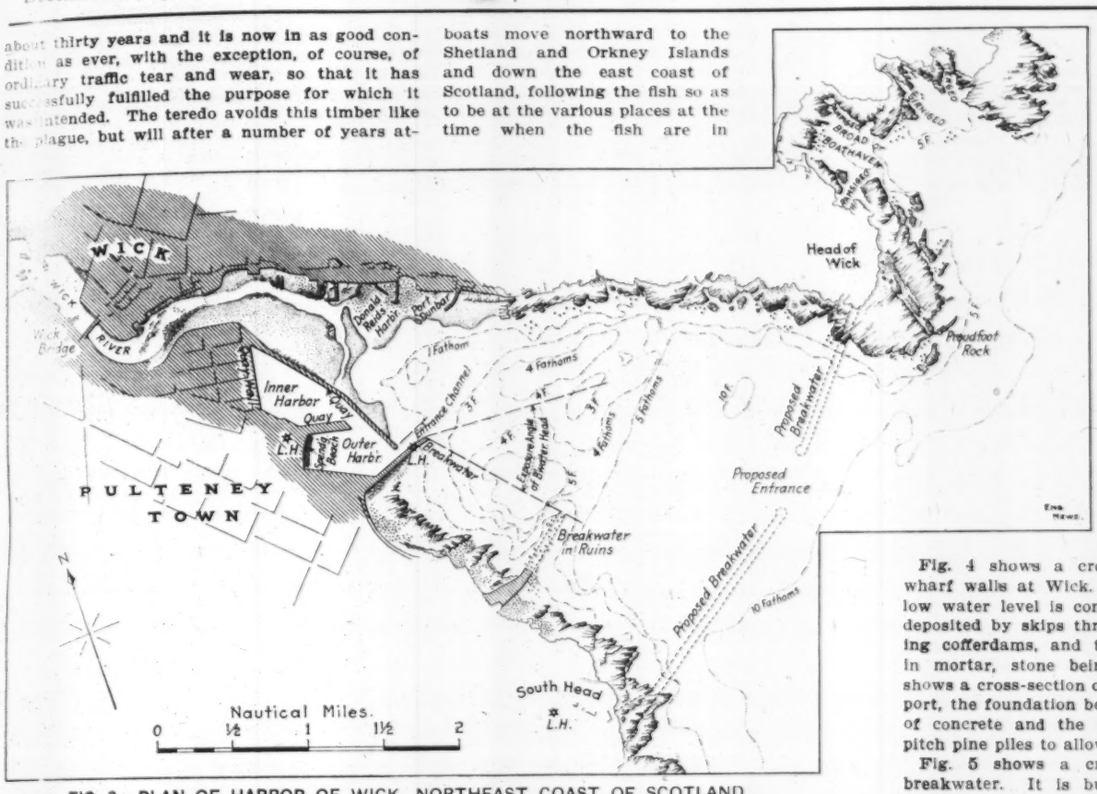


FIG. 3. PLAN OF HARBOR OF WICK, NORTHEAST COAST OF SCOTLAND.

STORNOWAY.—This town is situated on an excellent natural harbor on the east coast of the island of Lewis. Fig. 2 shows a cross-section of a timber wharf at this port. This wharf is constructed of greenheart timber with creosoted pitch pine in the above water work and decking. These two ports of Barra and Stornoway are frequented by hundreds of boats which use them as their headquarters during the earlier part of the fishing season. Later on in the season the boats move northward to the Shetland and Orkney Islands and down the east coast of Scotland, following the fish so as to be at the various places at the time when the fish are in the best condition. By the end of November they have reached Yarmouth in England and then return to their homes for the winter. In the Shetland Islands the chief fishery ports are Lerwick and Balta Sound, both of which have harbors in sheltered arms of the sea. In the Orkney Islands the chief port is Stromness, also in a deep sheltered bay, with landing piers for the boats. The new condition of things in which the fishing industry has assumed national rather than local importance, and in which the fishermen go further afield all around the coast, has brought prosperity to the outlying ports on these hitherto isolated islands on account of their possessing the requisite position and proximity to the fishing grounds.

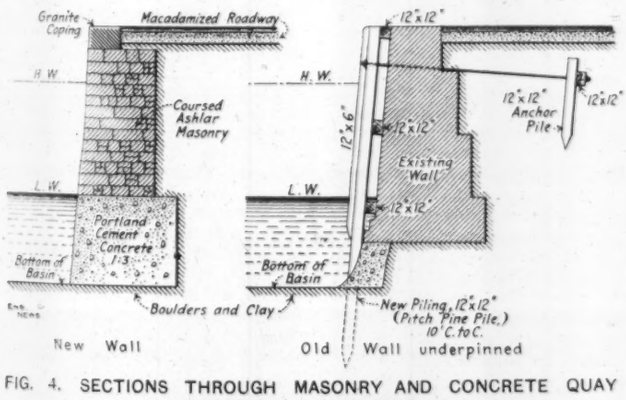


FIG. 4. SECTIONS THROUGH MASONRY AND CONCRETE QUAY WALLS IN WICK HARBOR.

WICK HARBOR.—This is situated in a triangular bay at the mouth of a small river of that name near the northeast point of the mainland of Scotland. Fig. 3 is a general plan of the harbor and bay. The harbor consists of two basins, an outer and inner, with wharf accommodation all around the enclosed space. Most of the material used in its construction is concrete or masonry, the more modern portions such as the south breakwater being constructed of concrete. These basins were originally almost dry at low tide, but have by repeated deepening been provided with a depth of 10 ft. at low water, with 14 ft. at low water alongside the breakwater, which can be used as a wharf in calm weather. None of the Scotch fishery harbors provide floating basins with entrance locks to give an even dock water level for the fishing boats, as is generally done in commercial harbors in Britain. It is necessary that a fishery harbor be open for entry at all states of the tide, so that the low water depth is the governing point. When a boat arrives in port it is necessary that its perishable cargo be unloaded as soon as possible. This could not be done if the vessel had to wait for the tide to rise to dock water level to permit of the lock gates being opened.

Fig. 4 shows a cross-section of one of the wharf walls at Wick. The lower portion below low water level is constructed of mass concrete deposited by skips through the water, thus saving cofferdams, and the upper of masonry set in mortar, stone being plentiful. Fig. 4 also shows a cross-section of a wharf wall at the same port, the foundation being underpinned by means of concrete and the wall faced with creosoted pitch pine piles to allow the basin to be deepened.

Fig. 5 shows a cross-section of the south breakwater. It is built of mass concrete deposited in forms "in situ." As the wall is built on a boulder clay foundation and as the depth of the foundation is not sufficient to escape wave erosion it is provided with an outer and inner detached concrete toe with sheet piling to prevent undermining.

It has been proposed at various times to extend the harbor by building breakwaters further out to enclose the bay. One breakwater starting from the south shore of the bay shown dotted on the plan, was commenced some years ago and when partially completed was so badly damaged in a storm that it was abandoned altogether. It consisted of a rubble mound carrying an outer and inner vertical wall superstructure of blocks, with rock filling between them. This upper portion has been entirely swept away. It has also since been proposed to construct two outer breakwaters starting from each head of the bay as shown on Fig. 3. It is proposed to construct these of mass concrete, using a large amount of stone as displacers, making it a close approximation to rubble concrete to minimize the quantity of cement. As the port has been so unfortunate with the rubble mound type, it is proposed to use the vertical monolithic type of wall in this case. The site is a very exposed one from the southeast, the direction of the port's longest water fetch extending to the coast of Germany. The funnel-shaped mouth of the bay which faces that direc-

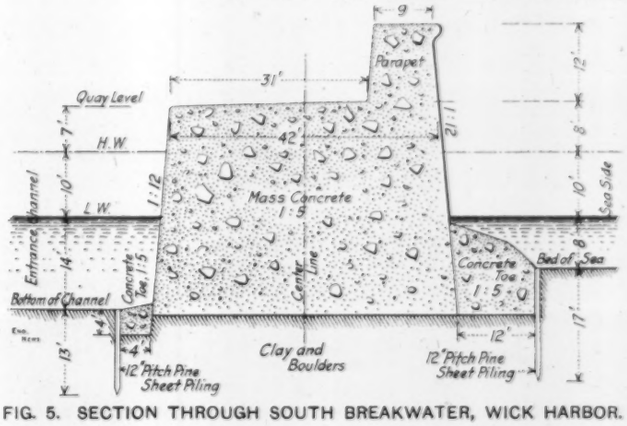


FIG. 5. SECTION THROUGH SOUTH BREAKWATER, WICK HARBOR.

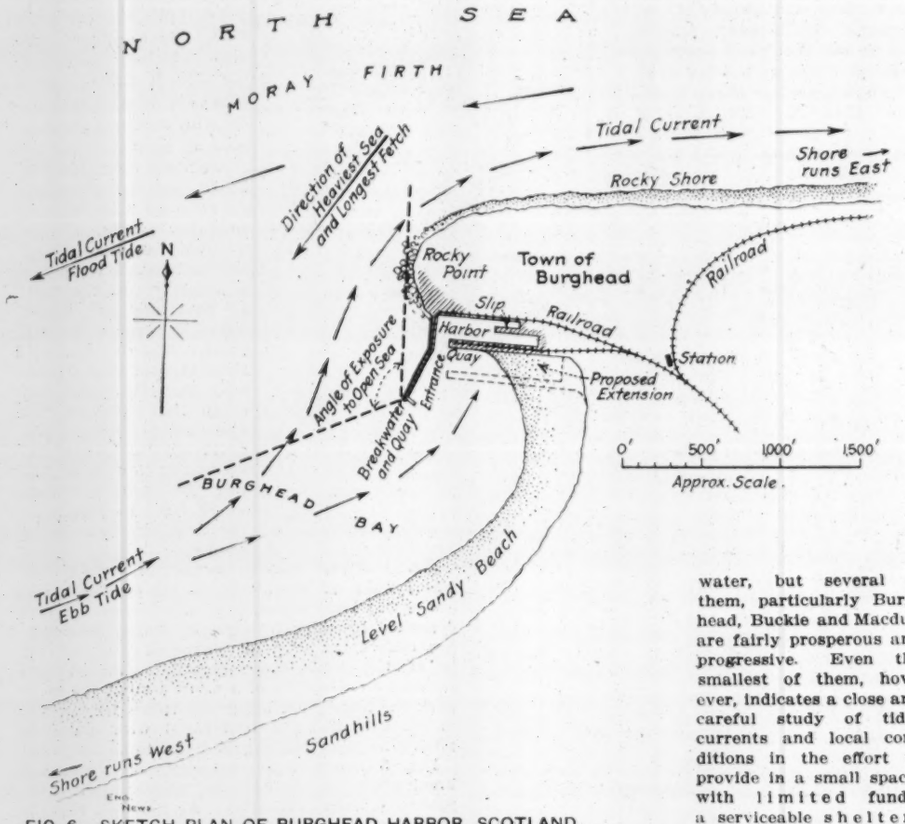


FIG. 6. SKETCH PLAN OF BURGHEAD HARBOR, SCOTLAND.

tion tends to concentrate the wave energy which expends itself with terrific force on any obstruction placed in its way. As a sample of this the well known fact may be cited of the total removal "en masse" of a block of concrete forming the head of the superstructure of the ruined breakwater. This block weighed 2,600 tons and was strongly reinforced with old rails. The rubble foundation was undermined and the block toppled over from its position into the inner side of the breakwater. Waves measuring 40 ft. high from trough to crest have been observed in Wick Bay.

Southward from Wick along the coast are dotted at intervals fishing villages and towns of varying sizes, each with its own harbor. The south shore of the Moray Firth particularly is the home of the North Sea fisherman. In the hundred miles of shore line between Inverness at the western angle and Fraserburgh at the southeastern angle of the Moray Firth, there are no less than 19 towns and villages, all more or less dependent on the fishing industry. This gives an average distance apart of about five miles. These places vary in population from 1,000 to 10,000. Many of the harbors of these fishing ports are small. Some which have lagged behind in the race are partly dry at low water, but several of them, particularly Burghead, Buckie and Macduff are fairly prosperous and progressive. Even the smallest of them, however, indicates a close and careful study of tidal currents and local conditions in the effort to provide in a small space, with limited funds, a serviceable shelter. The harbors are without exception purely artificial, some of them even are built on the open coast and not even in a bay. The entrances are in most cases so placed as to face in the direction which will be easy to navigate by sailing boats and at the same time face away from the direction of greatest sea exposure, so as to shelter the enclosed area as much as possible.

The total area enclosed by these ports is so small that they sometimes cannot afford to construct them always facing in the best direction for navigation, as by so doing it would convert the enclosed area into little else than a wave spending beach in a storm from that direction. Of two evils they have perforce to choose the lesser. They are also more or less troubled by

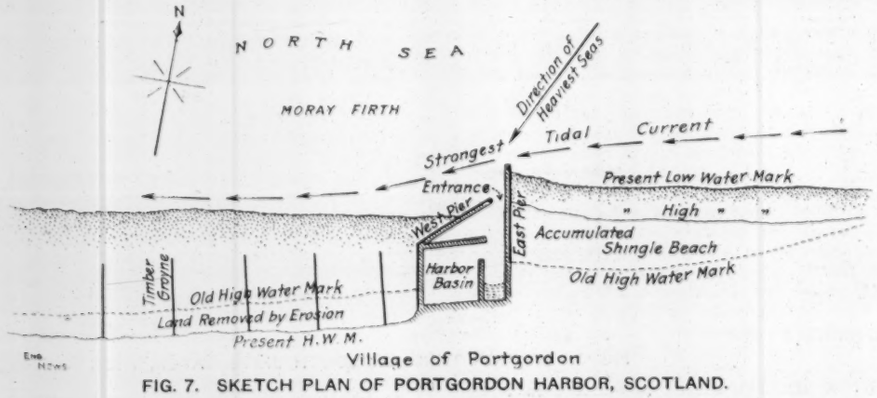


FIG. 7. SKETCH PLAN OF PORTGORDON HARBOR, SCOTLAND.

silting caused by beach travel, except those which are situated in deep bays. This silting is also another point to be considered in entrance design. The entrance cannot face out to sea very well, but has to be turned in a direction more or less parallel to the general coast line. If it is necessary to face it westward for exposure reasons, and the beach travel happens to come from the westward the result will be silting of the entrance and basins.

This is one of the possible difficulties to be met and compromised with, so that an effort has to be made to face the entrance in the [illegible] way to allow the silt laden shore current [illegible] pass without entering the harbor and con[illegible]ently slowing down and depositing the mat[illegible] they carry.

This beach travel may not be very [illegible]rent, but by continued silting it soon n[illegible]states dredging, which is a financial drain [illegible] these small places.

Figs. 6-8 show plans of several of t[illegible] harbors. They indicate the direction of the[illegible]aviest seas and longest water fetch and als[illegible]he direction of the tidal currents and beach [illegible]vel, if any.

BURGHEAD HARBOR.—The inner p[illegible]on of the breakwater at Burghead Harbor, s[illegible]n in plan in Fig. 6, consists of two walls c[illegible]nected at 20 ft. c. to c. by cross-diaphragm [illegible]ncrete walls 5 ft. thick. The core is of hard m[illegible]erial. The toe of the inner wall is supported b[illegible] sheet piling to allow the berth to be dredged [illegible]long-side. The outer portion of the breakw[illegible]er is built of concrete in bags of a large s[illegible]e deposited in jute sacking, from a hopper barge with an opening bottom. The superstructure is of mass concrete. This wall is built on a foundation of sand and boulders. The site is not a very exposed one, the longest water fetch being only about 50 miles within its angle of exposure, though the swell from the northeastward wheels round and strikes the breakwater. Considerable trouble is experienced at the harbor with silting in the entrance behind the breakwater. The sand travels along from the adjoining beach and as the breakwater projects out like an arm it settles in the slack water behind it.

It is doubtful whether an open work pier would not have been a better design allowing the sand laden shore current traveling eastward to pass through. The port maintains a bucket grab dredge to clear away silt.

In most of the harbors on the south coast of the Moray Firth, the entrances face the westward. This is the direction of the shortest water fetch, the direction of the heaviest seas being from the northeastward. The prevailing winds are from west to southwest.

The design of the entrance is perhaps the question of chief importance, as a faulty one lays the enclosed space open to silting or wave motion.

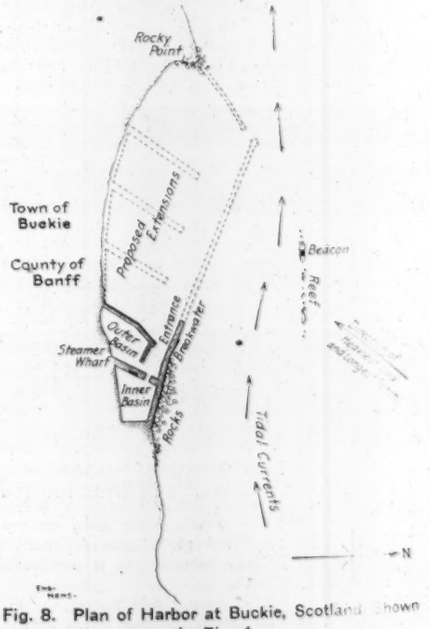


Fig. 8. Plan of Harbor at Buckie, Scotland [illegible]hown in Fig. 1.

If the entrance of a small harbor faced [illegible] open sea, the width of entrance is nece[illegible]ily so great in proportion to the enclosed wa[illegible] space that the waves have no room to exp[illegible] themselves. In a large harbor the ratio o[illegible]ntrance width to water area is so much sm[illegible]er that

the designer can afford to place it to the best advantage.

Wave Motion.

The question of the decrease of wave motion in an enclosed space is necessarily one of greater importance to a small than to a large port, though neither of them can afford to ignore it.

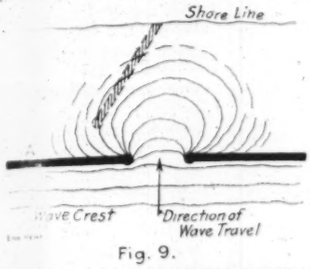


Fig. 9.

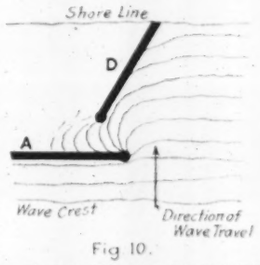


Fig. 10.

FIGS. 9-10. DIAGRAMMATIC SKETCHES OF THE BEHAVIOR OF WAVES AGAINST BREAKWATER HEADS.

By reference to the above sketches Figs. 9-10 the point will be easily understood.

The writer has closely observed wave motion, at various shapes of entrances, but these two sketches will serve sufficiently well for illustrative purposes.

Fig. 9 shows a square and Fig. 10 a deflected entrance. Assuming a wave to travel towards the breakwater "A" which lies parallel to the shore line in both cases, then in Fig. 9 the wave will enter and spread out like a fan. The arrows indicate the approximate direction of the wave motion and the lines the direction of the wave crest. The wave length and height will decrease as it proceeds inward, continuing to be greatest at its central point along a line at right angles to the initial direction of the wave crest and decreasing towards the heads of the breakwater, till finally it expands and loses its strength by deflection in this case caused by the fluid friction of water particles with the breakwater heads and with the calm water behind them. Now take Fig. 10 which has the breakwater "A" overlapping the wall "D." The lines indicate the direction of the wave crest. By placing the wall "D" in Fig. 10 over Fig. 9, as shown dotted, the small proportion of wave motion gaining admission to the deflected form of entrance, when compared to a square one will be understood.

The initial direction of the wave travel and the depth of water govern the exact form and size of the waves which pass into the entrance. Buckie Harbor shown on Fig. 8 is typical of this latter arrangement. Its entrance opens to the westward on a comparatively sheltered bay and has a small exposure angle in that direction. It is provided with an outer basin which receives any wave motion that may enter. The inner basin is perfectly protected, and this is accomplished within a distance of 400 ft. from the open sea. Since the addition of a short extension of overlapping north breakwater recently, the outer basin is also calm except in the very roughest weather. Unfortunately, this class of entrance necessitates a vessel getting broadside on to a sea in taking the entrance, to which sailors very naturally object in rough weather. A more nearly square on entrance can be taken on a straight run from sea.

BUCKIE HARBOR.—Fig. 11 gives a cross-section of the north breakwater. It is built of concrete of varying proportions and is provided with a heavy parapet and lighthouse passage, though the latter is required but seldom. This work was built about 35 years ago, and beyond ordinary damage the concrete remains in excellent condition and shows no evident signs of failure beyond some minor cracking and pitting.

The depth of water is 13 ft. at low water at the breakwater at Buckie, so that the foundation is not sufficiently deep down to escape wave motion and suction. It is generally acknowledged that with a 20-ft. maximum wave, which is the approximate maximum at this port, a depth of at least 30 ft. below low water level is necessary to get clear of wave motion which would induce dangerous scour in a breakwater foundation that is 20 ft. below the normal oscillation level of the wave trough.

Ordinary oscillating waves are harmless to a foundation placed in deep water beyond wave motion, but when the foundation of the wall is placed at a sufficiently high level, the obstruction causes eddies and converts the wave into one in which the water particles travel in a horizontal as well as vertical direction. The consequent circular movement of the water induces erosion and scour. This particular form of scour can only be prevented by going down to a level beyond the wave motion or by adding a detached toe around the foundation which will adjust itself to any change in the ground level and protect the main wall as was done at Wick Breakwater shown in Fig. 5. If the foundation is solid rock this is of course unnecessary. Fig. 12 shows a cross-section of a timber wharf in the outer basin at Buckie. The piles are of Demarara greenheart timber and the superstructure of creosoted pitch pine. The fenders are of American rock elm. The wharf has concrete side walls with stone filling between them and a wave breaker 3 × 9-in. planks with 2-in. spaces between is placed vertically in the center to check any wave motion from passing through into the outer basin.

Fig. 13 shows a cross-section of the steamer wharf. The walls are of mass concrete of gravity section, the filling between them being rubble from the harbor basin excavation. The roadway is of concrete 12 ins. thick. This harbor has been acquired lately by the town of Buckie and extensive improvement schemes are about to be begun.

The reader will note that the plans of some of these harbors present a somewhat irregular and cramped appearance without any very apparent reason. This is the result of comparatively small extensions carried out at different periods. Each extension is expected to fulfil some definite purpose of its own and does not sometimes, as it ought, form part of a comprehensive scheme, because the port may never have the funds to finish it. On account of the peculiar nature of the traffic a fishery harbor requires as great a length of quay space as possible for a given water area, but many of these ports could have been laid out to much better advantage with the same length of quays as they now have, enclosing a greater area which would have allowed of the construction of a cheaper form of internal works if the schemes had been carried out as a whole, instead of piecemeal.

PORTGORDON.—Fig. 7 shows the plan of another fishery harbor at Portgordon. It is built of concrete on an exposed shore, the entrance facing right out to sea. This direction of the entrance necessitates an awkward turn in taking the harbor basin and shows the difficulty with this form of entrance in a small harbor.

The most interesting fact in connection with this harbor is the effect it has produced on the adjoining beach. It illustrates very well the difficulty often experienced in building an obstruction which stops beach travel. The shore is rocky, overlain with large quantities of shingle and sand. The strongest current travels westward along the shore, and we find that the beach material has accumulated on the eastern side of the entrance pier until the high water mark has almost reached the pier head. On the western

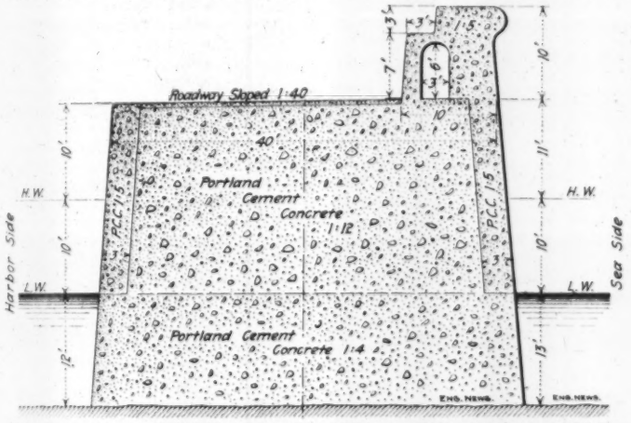


FIG. 11. SECTION THROUGH NORTH BREAKWATER, BUCKIE HARBOR.

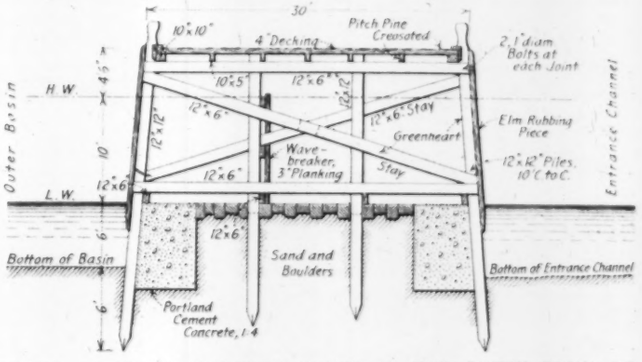


FIG. 12. SECTION THROUGH WHARF IN THE OUTER BASIN OF BUCKIE HARBOR.
(This wharf is sheltered from the heavy wave action.)

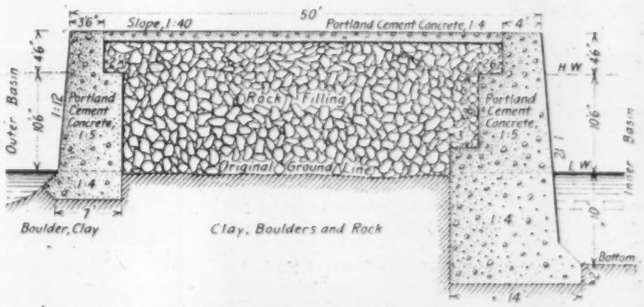


Fig. 13. SECTION OF LARGE BREAKWATER AT MIDDLE JETTY, BUCKIE HARBOR.
(This breakwater is sheltered from wave action.)

side the beach has been eroded and denuded of shingle for about a mile beyond the harbor, the road and village being threatened. Timber groins have been built on the western side at right angles to the shore, but these are of little use and must continue to be so until the beach has accumulated sufficiently on the eastern side to allow the beach material to resume its normal travel past the harbor and so supply the deficiency. This is the result of an ill-advised design of the harbor which obstructs this material instead of allowing it to pass. This is a very common trouble at larger ports built on an unstable beach with a tidal current running parallel to the shore which carries wave eroded material with it, in suspension. The Madras harbor is a similar well known example on a large scale. Other costly lessons experienced by large ports can all find their counter part in these small ports, and can be studied with profit by the harbor designer.

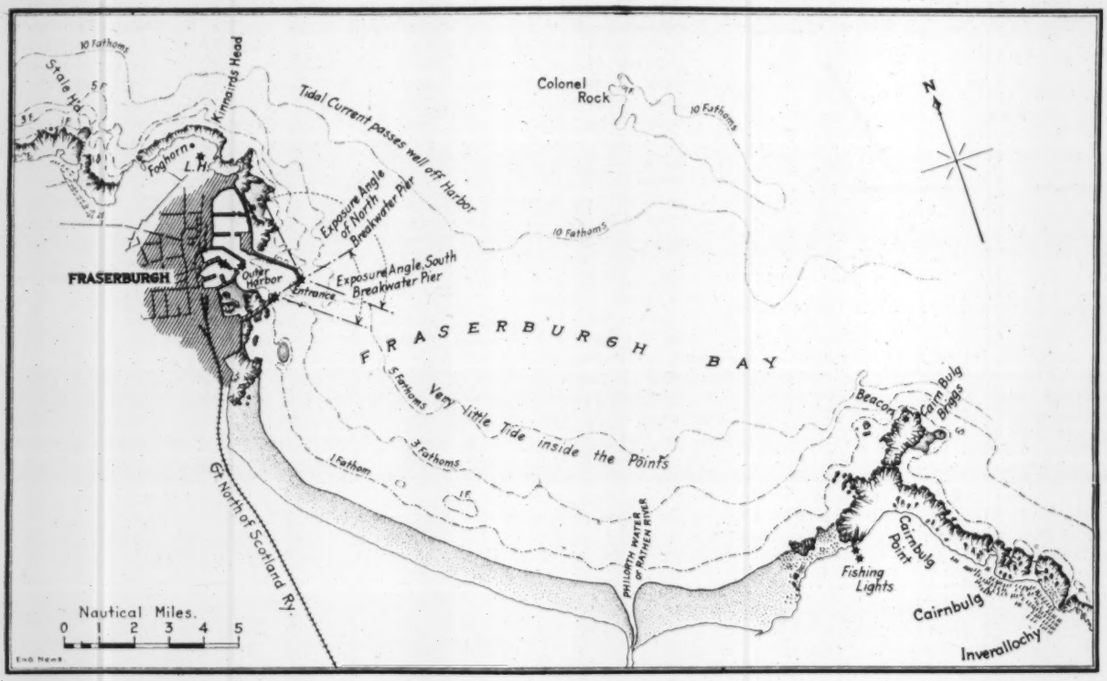


FIG. 14. MAP OF FISHING HARBOR AT FRASERBURGH, ON THE EAST COAST OF SCOTLAND.

Some harbors have attempted to provide for this by leaving a passage at the inner ends of the projecting piers, but this may cause silting in the sheltered area. On a rocky beach this trouble from erosion caused by the obstruction of beach travel is not generally encountered, though material may accumulate against one side of the work. Wave motion alone will not cause beach erosion, and tidal currents alone will only do so very slowly unless their speed is great, but a combination of both in which the waves stir up the beach material and the current transports it will do so very rapidly by increasing the grade of the beach. If this loss is not supplied by other beach material being carried along then the deficiency must be supplied from the shore above the water line until the beach has again acquired its natural stable slope. This example shows that the small fishery harbors are not by any means immune from the troubles of the large ports. Sometimes indeed their very existence is threatened. It will be noted from a study of the plans of these harbors that they are placed, if possible, at one side or end of a bay in such a way that the entrance faces towards the opposite side of the bay and is protected by a projecting pier. Also it is generally placed so as to obstruct beach travel as little as possible.

FRASERBURGH HARBOR.—Fig. 4 shows a plan of Fraserburgh harbor. This is one of the largest and most enterprising fishery ports in Scotland. It consists of a series of curved piers built at different periods running out from the shore and enclosing areas which have been deepened. The later works are built entirely of concrete. The site is a particularly trying one, placed as it is right on this projecting point of Scotland. It is exposed to the full force of the North Sea storms, and only the energy of the people has made it a success.

During the fishing season an enormous number of boats make this and the neighboring port of Peterhead their headquarters. These two ports have excellent railway facilities and also have very advantageous sites, projecting as they do well out to sea near the large fishing grounds. The entrance at Fraserburgh is the nearest approach to being straight out to sea of any of these fishery ports. It is consequently easy to navigate. The large outer basin now used as a wave spending basin is being deepened to provide additional accommodation.

Fig. 16 shows a cross-section of the breakwater at Fraserburgh. The lower portion is built of concrete in bags, deposited from a hopper barge, with a mass concrete superstructure. This was one of the first sea works of this kind built in Britain. The faces of the work have been repaired by the addition of a layer of concrete about 6 ft. thick, bonded to the old work. This was rendered necessary by the pounding of the concrete and bagwork which fell out in large pieces.

The matrix lost its cementing power and the concrete crumbled up badly and was eroded by the wave action. On examination this concrete looked spongy and was easily worn away by the fingers. The cement seemed to loose its adhesive properties and became powdery in appearance. This powder was easily washed out by the wave action, leaving the remaining sand and stone porous and easily broken up. Some of the holes were several feet deep. The damage showed most in the sea side, where the wave action which assisted by eroding disintegrated material was greatest, thus removing decomposed material which would have acted as a protection and exposing a fresh surface to the sea water. The proportions of cement to aggregate used in this work were 1:9 in calm and 1:7 in rough weather. These proportions of cement are now acknowledged to have been much too low for the work and were doubtless the chief cause of the damage.

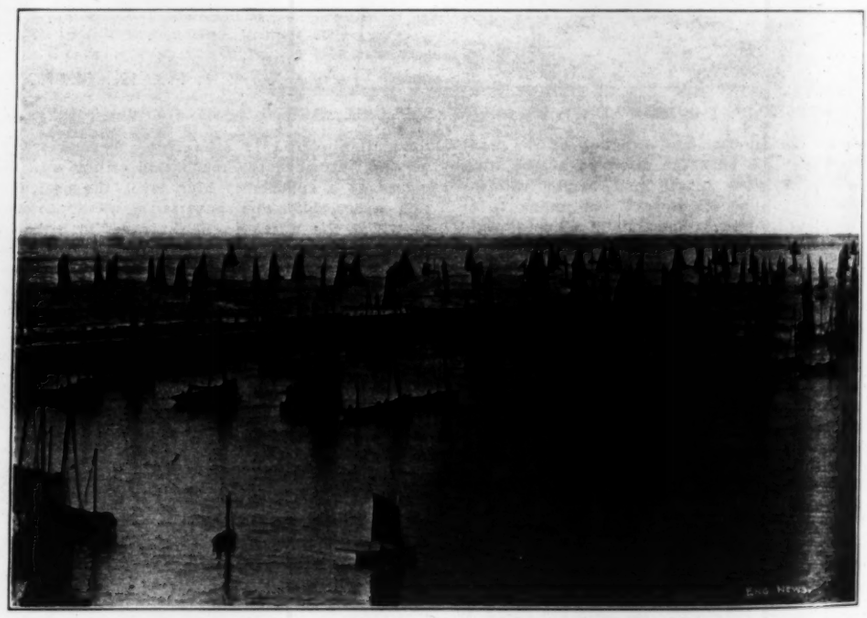


FIG. 15. VIEW OF FRASERBURGH HARBOR, SHOWING FISHING FLEET LEAVING PORT FOR FISHING GROUNDS.

The failure of similar pieces of construction and the reasons therefore are discussed farther along in this article under the subhead "Concrete Composition for Sea-Water Construction."

PETERHEAD.—The Harbor of Peterhead consists of two parts, the Fishery Harbor and the Harbor of Refuge. (See Fig. 18.) The former is

built between the mainland and a rocky headland and has two entrances, one from the north and the other from the south. The Harbor of Refuge is being built by the British Admiralty and consists of two rubble mound breakwaters with a blockwork superstructure, which enclose

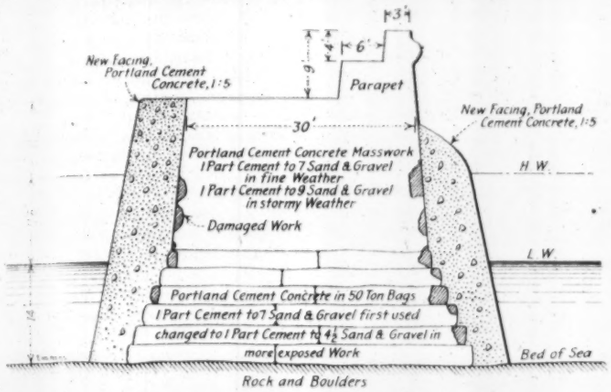

New Facing, Portland Cement Concrete, 1:5
Parapet
6'
30'
New Facing, Portland Cement Concrete, 1:5
Portland Cement Concrete Masswork
1 Part Cement to 7 Sand & Gravel in Fine Weather
1 Part Cement to 9 Sand & Gravel in stormy Weather
H.W.
Damaged Work
L.W.
Portland Cement Concrete in 50 Ton Bags
1 Part Cement to 7 Sand & Gravel first used
changed to 1 Part Cement to 4½ Sand & Gravel in more exposed Work
Bed of Sea
Rock and Boulders

FIG. 16. SECTION THROUGH BREAKWATER, FRASERBURGH HARBOR, SHOWING REPAIR FACEWORK.
(This breakwater is exposed to most violent wave action.)

the South Bay. The port is at present carrying out extensive deepening works in the south basin. This port will benefit very much by the construction of the Harbor of Refuge.

STONEHAVEN.—Fig. 19 shows a plan of the Stonehaven Fishery Harbor. It is a good example of the gradual growth from time to time of these fishing ports. The north pier marked "A" is the original structure. It is built of masonry blocks securely bonded together and protects a small bay from the northeast gales. Afterwards piers "B" and "C" were added, giving a South Basin and converting the original North Basin into a wave spending basin. The two latter works are of concrete. Recently an outer breakwater also available for a quay has been built. The inner and middle sections consist of parallel sidewalls of concrete, the filling between them being rock from excavation, and the roadway of concrete. The outer arm is of mass concrete, the high proportion of cement in which will be noted below low water and on the outer surfaces.

ABERDEEN.—The leading fishery port on the east coast of Scotland is Aberdeen, which next to Grimsby in England, is the most important fishing center in the British Isles. The harbor which is large and well equipped is situated at the mouth of the River Dee. The entrance is by way of the channel of the river, which has been deepened to admit large steamers. The docks consist of two basins with tidal locks, and two tidal basins. The former are used for commercial purposes and the latter for the fishing trade. The docks have been constructed in what was once a shallow sandy lagoon near the river mouth. One of the tidal basins is reserved for trawling vessels and is equipped with a fish market all around it on the wharf. This building is provided with a concrete floor about 70 ft. wide, high at the back and sloping downwards towards the quay with a slope of about 1 in 20. Here the fish are discharged and laid out in rows on the floor and sold. The roof of the building is carried by steel trusses on columns. Direct railway connection is provided and there is a special fish express service to the southern market. The herring fishing fleet use the outer part of this basin and also the dock in the river channel. There are several hundred trawlers fishing regularly from this port. The fish are stored in ice on board the vessels, as the voyages often extend over a week. Sometimes as much as 2,000 tons of whitefish are landed in a single day at this port. The herring fishing industry of the port is also a very important one, though it is not continuous all the year round like the trawling industry.

Fig. 20 shows a general plan of the port of Aberdeen. The south breakwater is constructed of concrete blocks up to 3 ft. above low water with a mass concrete superstructure and lighthouse. The location of the breakwater is a very exposed one, as its center line is parallel to the general coast line and it receives the full force of the heavy gales from that direction. It was once badly damaged by the air compressing in the joints of the block work by wave impact during a storm several years ago. This forced out the blocks on the seaward face and inflicted considerable damage, cracking the mass concrete superstructure badly. The damage was ascribed to air becoming compressed in the joints on the outer face and failing to escape through the block work to the inner face or upwards through the mass work superstructure. The inner part of the breakwater is founded on rock and the outer on boulder clay. This boulder clay foundation, not being at a sufficient depth to escape wave motion, became eroded at the toe of the wall and it was found necessary to lay large bags of concrete along the base of the wall, to protect it. These bags adjust themselves to the erosion and protect the foundation. As is to be expected from its exposed site, the breakwater requires occasional repairs, but on the whole it has stood the test of the battering that it receives remarkably well. The mass concrete top is rather badly cracked, due doubtless to causes previously discussed. Fig. 21 shows a photograph of a wave striking the breakwater in a northeaster. The sea bed in shallow water on the seaward side of a breakwater should be cleared of any loose boulders, as these may be thrown against the wall in a storm and cause severe damage.

The superstructures of breakwaters built in rubble mounds are often damaged by the waves lifting loose rubble and throwing it against the wall, thus aiding other destructive agencies in the wearing away of the wall.

Any weak seams or cavities in the rock on the sea bed on the outer side of a wall should be filled up. If this is not done the construction of the wall will often increase the tear and wear on the rock surface and cause any weak parts to break up.

Fig. 22 gives a cross-section of the north breakwater. The foundation is of concrete in bags, similar to the Burghead and Fraserburgh breakwaters, with a mass concrete superstructure. The wall is built on a sandy foundation overlying boulder clay. The site is not nearly such an exposed one as that of the south breakwater, being more in the nature of a training wall, though the outer end is sometimes rather severely tried. Fault has been found by harbor engineers with the design of this entrance on the score that it presents to the northeastward (which is the direction of the heaviest sea) a funnel-shaped opening with the widest end seawards instead of harborwards, thus tending to concentrate the wave action in the entrance channel. This is undoubtedly the case in seas from the northeastward, but it must be remembered that the present plan was governed to a great extent by structures already built. As is the case in many of the other smaller Scotch fishery harbors the engineers for extension works had to utilize and incorporate existing work into their schemes for improvement, although in many cases it would have paid to ignore the existing structures entirely or in part, as many of these smaller original works were unsuitable or incapable of properly forming part of a larger scheme of extension. The owners of these ports generally insist, however, rightly or wrongly, in fitting in the new work to the old, although it often militates against its future usefulness by so doing. Of course in the case of Aberdeen harbor it has the advantage of a long entrance channel which acts as a spending basin before reaching the docks, but it must also be remembered that with a better design this area would be available for docks. The other smaller fishing ports cannot afford to waste water space, but Aberdeen has had sufficient room for dock extension in the neighborhood of the docks so that it does not as yet affect the port very much.

FIG. 17. NEAR VIEW OF FRASERBURGH HARBOR, SHOWING BREAKWATER.

Docking of Boats.

The usual means hitherto in use of docking a fishing boat for overhauling it, is by running it ashore on a sheltered beach or boat slip at high water and doing the repair work when the tide has receded. Now, however, with the increasing size of boats and steel drifters and trawlers it has become necessary to provide other and better means of doing so. Aberdeen, Peterhead and Fraserburgh possess graving docks for this purpose. The former has also floating pontoon

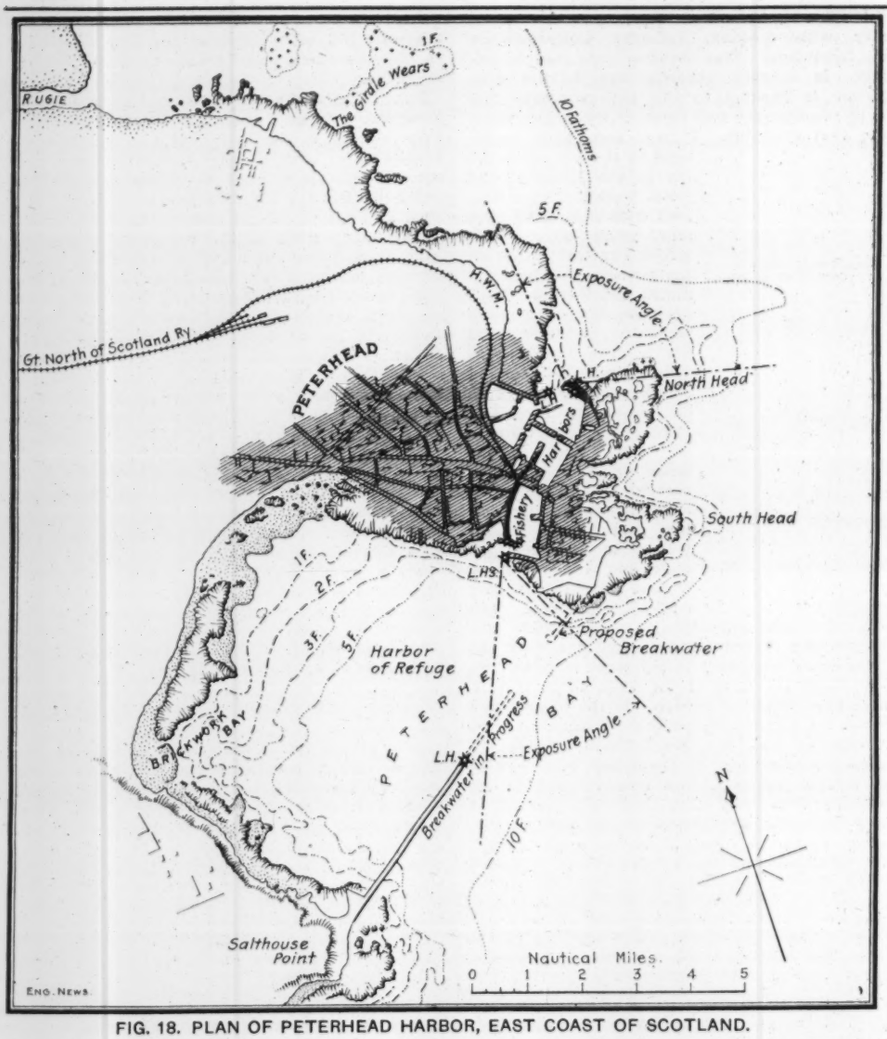


FIG. 18. PLAN OF PETERHEAD HARBOR, EAST COAST OF SCOTLAND.

docks, and some of the other ports are considering their installation. Patent cradle slips are also in use.

Materials of Construction.

The material for aggregate for concrete construction is generally coarse shingle and sand obtained from suitable places on the sea beach. In the larger walls a large amount of rubble stone from excavation in the basins or from adjoining sources are used as displacers in the concrete generally to about 15% of the entire mass. These stones are washed clean and must be angular in form and must not show cracks, they are bedded well clear of each other in the concrete mass. The proportions of the concrete given on the drawings is independent of these displacers and applies only to the actual mixed material.

Concrete Composition for Sea-Water Construction.

Signs of the failure of the cement similar to those noted above at Fraserburgh have appeared in other works with concrete of a similar nature constructed at the same period in breakwaters, notably at Burghead, previously mentioned, and at Newhaven, on the south coast of England, and at Wicklow in Ireland. The writer has not noticed the same pronounced symptoms of decay so far in works constructed a few years later, and is disposed to think that the primary cause of decay was the use of too low a proportion of a cement which was none too good for this class of work. The usual chemical specification for cement for use in later years has been as follows:

Not more than 61% lime.
Not more than 1¼% magnesia.
Not more than 1¼% sulphides and sulphates of sulphuric acid.
Not more than .75% moisture.
Not less than 23% silica.
Not less than 12% of alumina and oxide of iron.

From this it will be seen that only low percentages of magnesia and sulphuric acid are permitted while a fairly large percentage of alumina is allowed (to which objection is now often taken in sea water) and also of oxide of iron.

The physical tests are the usual ones demanded for ordinary commercial cement. The concrete piers built at Buckie and also at several other fishery harbors a few years later presumably with a better knowledge of sea work do not show any serious signs of decay other than those attributable to ordinary tear and wear, which is inevitable in this class of work. The more recent works seem to have so far overcome this trouble of concrete decay, at least in its most aggravated form.

In concrete work exposed to heavy seas it is difficult in examining the damage sometimes to arrive at the correct cause. In a wall subject to heavy wave impact perhaps as high as 3 tons per sq. ft. in a storm it may be due to shock causing vibration of the concrete and consequent fatigue of the cementing material by the continual pounding and scouring of the waves or it may be due to chemical decomposition of the cement, or a combination of both. The latter combination was very probably the cause of failure of the Fraserburgh breakwater. As the sea face of the wall below the high water level was the most seriously damaged, while part of the wall above high water level is well preserved. Waves which carry beach material in suspension also damage concrete, as small pebbles when thrown against the wall will wash out the softer matrix and wear away the concrete.

It is necessary in order to find out whether the cause of failure is a chemical one to have a wall constructed at the same time and of the same materials but in a sheltered and protected position for comparative purposes. Apart from these causes of disintegration of the concrete there may be others, such as temperature strain, that is the change of length of the wall due to difference of temperature. This causes stresses which are very trying to the work.

If there is no provision made for expansion and contraction by open joints, the wall must crack to allow the mass to adjust itself to its varying dimensions. The importance of the effect of temperature changes on large masses of masonry is well illustrated by the extraordinary precautions being taken to allow for it in the heightening of the Assuan Dam* on the Nile. To meet this, many breakwaters are constructed of large blocks, but in spite of possible cracking the continuous monolithic wall possesses the power of great resistance to wave impact, and even blocks of large size will crack. Take a solid wall with the upper 10 ft. exposed to the rays of the sun and heated up by absorbed heat to a temperature of perhaps 150° F. Along comes a storm which suddenly douches the outer crust with water at perhaps 50° F. The outer crust suddenly contracts and tends to separate from the core along a series of planes parallel to the surface of the wall.

This goes on repeatedly until perhaps finally the outer layers scale off and fall away. The portion of the wall between high and low water is particularly susceptible to this form of damage, as it is heated and cooled twice a day in

*Engineering News, Sept. 30, 1909, p. 339.

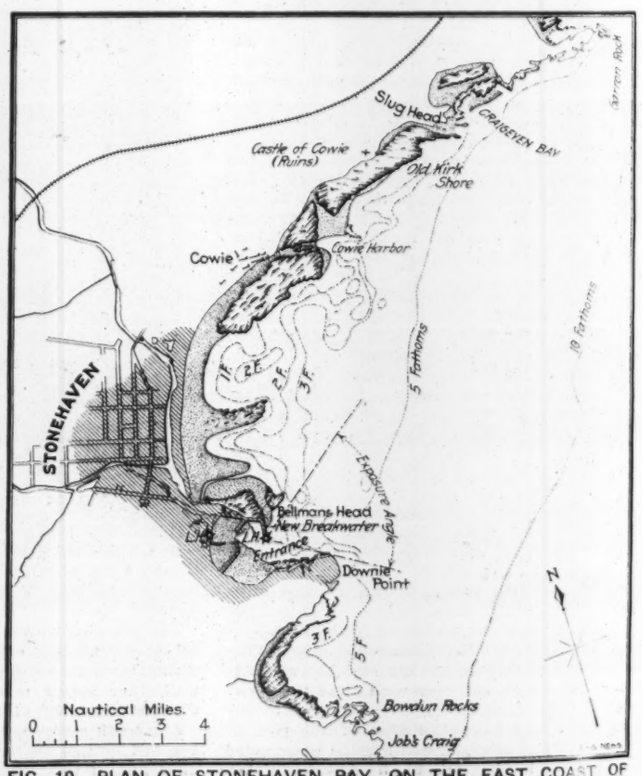


FIG. 19. PLAN OF STONEHAVEN BAY, ON THE EAST COAST OF SCOTLAND.

tidal water. These surface shearing stresses cause more damage to a wall of this sort than those due to change of length of the work, for even after the work has cracked and adjusted itself to longitudinal strain the local surface stresses continue to act. These cracks in themselves would not perhaps be so injurious, were it not that they admit the sea water into the wall. The water deposits material in the cracks, generally magnesia, from the sea water, and tends to burst off the subdivided pieces of concrete. If there are any signs of chemical decay in the cement, we can readily understand that these cracks would hasten the decay by increasing the exposed surface.

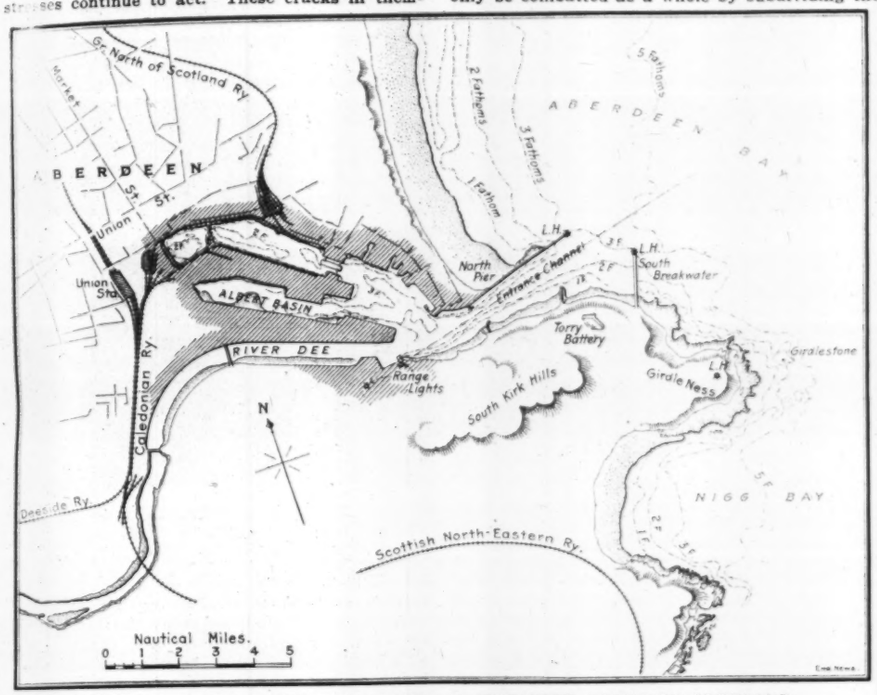


FIG. 20. PLAN OF ABERDEEN HARBOR, ON THE EAST COAST OF SCOTLAND.

Another cause of decay in concrete in water subject to low temperature, is freezing of water imprisoned in the body of the wall. In cases of damage around the water line in fresh water, the damage can generally be attributed to a great extent to this cause. In sea works subject to changing water levels the water enters the pores of the concrete and any cracks or joints, and if it cannot flow out freely it freezes when the tide falls, expanding in the process and perhaps bursting off pieces of the concrete along any cracks that may exist, or forming new ones.

Again in sea work exposed to wave action, we have air compression and suction in cracks and voids. A wave striking a wall compresses the air between it and the wall forcing it into the openings and creating a vacuum on the recoil of the wave, which produces a peculiar suction. The writer, without wishing to exaggerate, but with the idea that we learn more from our failures and a knowledge of the possible causes of them than from our successes, has purposely given prominence to some of the severest causes of damage to concrete in sea water. There still remain to trouble us perhaps faulty construction due to either a badly proportioned aggregate, making a porous and spongy concrete or too low a proportion of cement or faulty mixing and placing and possibly a bad cement or unsuitable aggregate. Taken for granted that our construction methods and materials are perfect, still we have a formidable enough list opposed to us.

Of course to ordinary quay walls, neither vibration nor air troubles apply, but we have in these tear and wear from the berthing of vessels to supply the deficiency.

Assume that we have a perfect concrete for this class of work, and we still have to enumerate:

(1) VIBRATION, which we cannot overcome, as it represents the resistance to the kinetic energy of the wave. It may cause decay even in the interior of a wall.

(2) TEMPERATURE STRESSES, which can only be combatted as a whole by subdividing the wall into blocks free to expand and contract independently of one another, but even by this means local stresses are unavoidable in the blocks themselves.

(3) FREEZING of imprisoned water, which obviously can only be prevented by making the concrete solid and impervious and so preventing the water from entering the work, or if it does enter it at joints to provide free means for it to drain out again.

(4) AIR COMPRESSION AND SUCTION in the wall requires the same remedy as freezing, but even then cannot be entirely overcome. The joints in a blockwork breakwater should generally be made dry and as close as possible, and should be made so as to allow imprisoned air to escape.

It is difficult to make or preserve perfectly tight mortar joints in blockwork in a breakwater, so that apart from other questions relative to joints it is better to leave them dry. Any effort to make a perfectly tight mortar joint under sea water generally results in at least partial failure. A partially open joint is more dangerous than an open one, as the former imprisons air and water around the water line.

One advantage the monolithic form of breakwater possesses is its great resisting power to wave energy for its cube. For example, take a one ton block with a cubic content of 16 ft. and measuring 4 × 2 × 2 ft. Taking one tone and 1 sq. ft. as units the ratio of weight to surface area is as 1 to 40. A small block obviously depends on the efficiency of its bonding to the adjacent ones to maintain its position.

Again take a 1,000-ton block containing 16,000 cu. ft. and measuring 40 × 20 × 20 ft. The ratio of its weight to surface area is as 1 is to 4. Thus the total force of wave impact on the block surface is ten times greater in the small block than in the large one in proportion to its displacement. Not only is the resistance of the large block due to its inertia greater, but its resistance to shear of the mass of the wall is also greater.

Concrete Depositing.

Most of this under-water work is built of 1:3 concrete, that is with 1 part cement, 1½ part sand, and 3 parts broken stone, or 1 part cement to 3 parts of suitable shingle. Perhaps this is needlessly high for the central portion of the walls, but it is the intention by so doing to make a general allowance for cement loss in depositing the concrete through the water. These walls are generally built in 20-ft. lengths the full width of the wall within timber forms. These are constructed of 12 × 12-in. vertical logs placed 4 ft. apart along the face, the lagging being of 3-in. timber. The lagging on the under water portion is lined with a double thickness of jute sacking weighing 30 oz. per sq. yd., and the above water part with a single layer of the same material. This is intended to prevent pitting of the wall face and damage to the green concrete by wave suction. The concrete is deposited through the water in 2-ton skips with opening bottoms. All under-water work, such as fixing forms is done by helmet divers. After the forms have been placed in position concreting should be done at once and finished as soon as possible as the form work is subject to damage in sudden weather changes. When concreting on an unfinished section is stopped it is carefully covered up to protect it and is afterwards scrubbed and cleaned by wire brushes to free it from the coating of inert material which generally forms on concrete surfaces in sea water, and which if left would prevent proper bond. On some of the earlier work of this class, before it was discovered that this material was inert, this was not done, and the result is visible in perfectly apparent horizontal joints in the mass work which form lines of weakness in the concrete. Advantage is taken of low tide to deposit the concrete above the low water line, so that no cement is lost in that part of the work. The writer has found from close observation of this and other similar work* that concrete can with proper precautions be deposited through fairly calm water by means of large skips with comparatively slight loss of cement. The larger the skip used the better are the results.

Concreting by this method is generally stopped

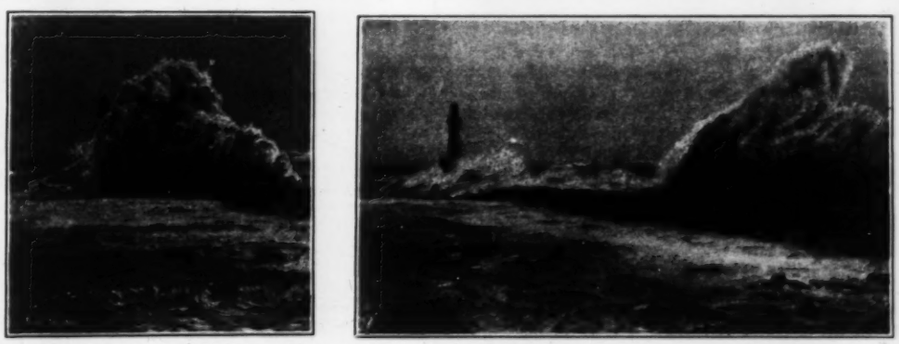


FIG. 21. VIEW OF 100-FT. WAVE IN A NORTHEASTER AT THE SOUTH BREAKWATER, ABERDEEN, SCOTLAND.

(The part of the breakwater showing above the water level on the inner side is about 25 ft. high and the lighthouse at the outer end is about 100 ft. above low water level.)

*Engineering News, July 1, 1909, p. 24.

when wave motion becomes at all troublesome, but in deep water below wave motion it can be carried out even through choppy water if the skip is properly protected from wash when being lowered.

If it were necessary to use the cofferdam method for this class of sea work, it would be impossible to construct it at anything like a reasonable cost, even if it were possible to employ it. The use of concrete blocks placed by large cranes and set by divers is another method used to obviate the necessity of depositing unset concrete through water. These blocks being built

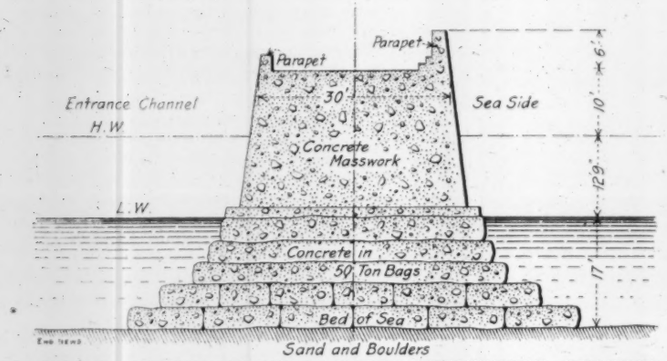


FIG. 22. SECTION THROUGH NORTH BREAKWATER, ABERDEEN HARBOR.

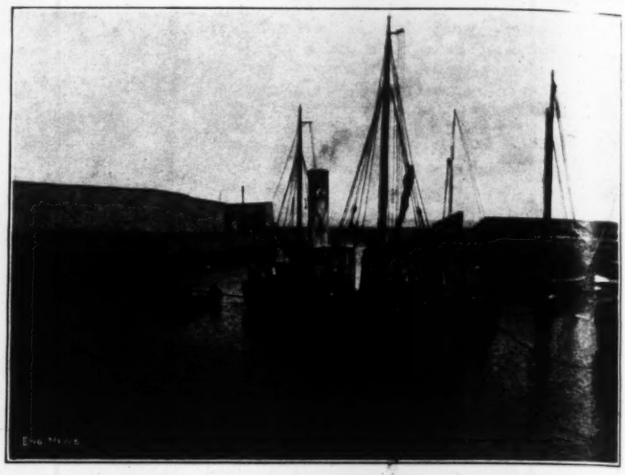


FIG. 23. VIEW OF A MODERN STEEL STEAM DRIVER USED IN THE FISHING FLEETS OFF SCOTLAND; TAKEN IN THE HARBOR AT LOSSIEMOUTH, ON THE NORTHEAST COAST OF SCOTLAND.

on land can be made with a smaller proportion of cement, but they must be made of very large size, and this necessitates costly cranes, etc., the cost of which for a small work might easily exceed the total expenditure on the work. For this reason mass concrete is peculiarly suitable for small works, as the cost of temporary structures and plant is comparatively low.

Forms for Concrete.

The forms for the walls generally consist of about 12 × 12-in. logs securely braced and carrying the lagging, which is generally of 3-in. lumber with planed joints and face. The lower ends of the logs are generally secured by means of old rails bolted to the sides, the ends of the rails being sunk in the sea bed.

Fig. 24 shows typical forms for the construction of a mass concrete breakwater.

Steel angles have been tried instead of logs and answer the purpose in sheltered situations, but when exposed to the full wave force they crumple up and would require to be made very heavy to resist. Logs have more resilience and stand better. In quay walls, built up movable panels of timber, secured by bolts, are used for forms.

Mixing Concrete.

The mixing of the concrete is generally done by machinery on the larger works. The material is mixed thoroughly. Sufficient water is added so that the concrete when freshly deposited in a mass will quake like a jelly and show a slight surplus of water when lightly tamped. For under water work the concrete is made rather dryer than for above water work. It is seldom made sloppy, however, as is often done in reinforced-concrete work. In this latter class of work it is more or less necessary to have the concrete fairly wet in order to get it to fill in around the small rods and wires. Some engineers go to excess in this and insist on making it not only wet but sloppy enough to almost run. Some excess water for reinforced work is doubtless a good thing, if only to overcome the carelessness of the human element in the work, who are not to be depended on to tamp the concrete round the rods with care. The writer, however, believes that the use of an excessive amount of water in mass concrete where this excuse does not exist is a method to be deprecated. Do not use too little water, as your concrete will be dry and require an excessive amount of ramming to consolidate it. Neither use an excessive amount of water, as it weakens the concrete. Rather run the middle and moderate course and use enough water in mass concrete to show a little excess and enough excess of water in reinforced-concrete work to allow the concrete to adapt itself to the surface of the reinforcing rods. This, to the writer, appears to be the whole of that vexed question, "water in concrete" in a nutshell. Individual opinion and judgment must always figure in this question as to what wet and dry really means.

Fresh water is always used, as certain chemicals present in sea water, such as magnesium sulphite, are injurious to the cement. When the concrete is made fairly dry for submarine work it forms a paste from which the cement is less easily lost by the action of the water, and as the mass is under water it will absorb any slight deficiency necessary to hydrate it thoroughly. Too dry a concrete, on the other hand, will not adapt itself well to the forms under water without being trimmed, which is a thing that should never be done under water, as it stirs up and causes loss of the cement.

Wrought-iron skips of various designs, with opening bottoms, are generally used for this class of work and give the most satisfactory results. The use of a tremie is limited to calm water on account of the difficulty in handling it in choppy water. Concrete deposited by skips under water has been found to give excellent results, and it is to be regretted that some engineers even yet look upon the depositing of concrete in an unset state through the water as in a highly experimental stage, as it is undoubtedly in some situations a great cost saver.

In connection with the use of Portland cement concrete in sea water as exemplified in these works, the writer would add that it is necessary to use a liberal proportion of cement in order to withstand the wearing action, both chemical and dynamic, of the sea water on the cement, and secure a dense and impervious concrete. Some of the earlier failures were no doubt hastened by the use of too small a proportion of cement in the aggregate. The later work which employed a richer concrete do not show any pronounced signs of decay. For underwater concrete deposited carefully through the water by skips a minimum proportion of one part cement to five of aggregate should be used. The outer surface of the walls for above water work should have the same minimum proportion for at least the outer 3 ft. of the wall. The center of the wall both for above and below low water mark may be made with a smaller proportion of cement. For reinforced-concrete piles for use in marine work the writer believes a minimum proportion of one part cement to three parts aggregate should be used, as the piles are of small section and have a large wetted surface in proportion to their cube. Hitherto quay walls built at these harbors of concrete have been of gravity section, but no doubt with the introduction of reinforced concrete the cantilever system of retaining wall construction by this method will come into use. Reinforced-concrete piles have already been in use for some years in wharf construction in Britain, and so far have given every satisfaction, but considerable time must necessarily elapse before they can be tested thoroughly and the effect of sea water on them noted. They are protected from traffic tear and wear by timber rubbing pieces on their outer faces and are well braced, so that the chief cause of their decay, if any, will be a chemical one.

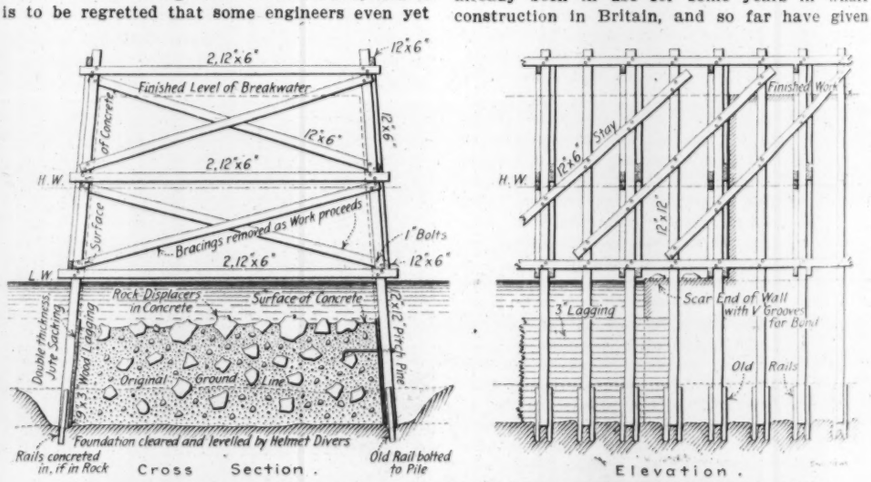


FIG. 24. TYPICAL DESIGN OF TIMBER FORMING USED IN CONSTRUCTING THE CONCRETE BREAKWATERS AT THE FISHERY HARBORS OF SCOTLAND.

Excavation.

Excavation in the harbor basins is generally done if possible in the dry by closing off sections of the area to be deepened by means of

timber cofferdams, preferably one basin at a time being enclosed by placing a dam at its entrance. Steam rock drills are mostly used in rock work, the blasting material being generally one of the nitro-glycerine compounds, the charges being fired electrically. In the entrances or where the cofferdam method is impracticable and where the material is too hard to dredge the excavation is done by drilling from barges or staging, the blasting charges being placed by helmet divers, the loosened material is removed by dredges, the large pieces being slung by chains. The works are not generally of sufficient size to justify the use of the diving bell for the purpose of submarine rock excavation, although it might have been used to advantage in some cases in sheltered places.

The following are a few prices for various classes of work at different ports; the costs give a fair average for the work:

COST OF CONCRETE PER CU. YD.

	Peterhead.	Macduff.	Stonehaven.
	Per cu. yd.		
Below low water 1:3 concrete	$9.00*	$6.00	$5.30
Between tides 1:5 and above water	4.25	5.10	4.20
Between tides 1 to 8	3.60	4.15	3.15

*The quantity of 1 to 3 at Peterhead was small, this being the chief reason for the unusually high cost. Accessibility of the site and the proximity of the work to raw materials govern the prices of course, as does also the exposure of the site.

Greenheart timber in 12 × 12-in. logs for piles, per cu. ft., add erection.....$1.50
Creosoted pitch pine timber, 12 × 12-in., 10 lbs. creosote per cu. ft., for piles, per cu. ft., add erection 0.40
Rock excavation below low water within cofferdams (cost of dam extra), per cu. yd..... 1.35
Rock excavation, submarine, per cu. yd..... 3.65

Allowance must be made for different labor costs in Britain.

Lighting.

The coast is well lighted by lighthouses maintained by the Lighthouse Board. In addition to this each of the ports maintains a guide light or series of lights to mark the position of the harbor entrance. The guide lights are generally low-power fixed lights, oil being used—but some of the larger ports have fairly large revolving lights. Many of the light towers are now built of concrete instead of masonry or steel and are quite satisfactory.

Some Mistakes of an Unsuccessful Engineer.

By "A Veteran."

I was led into the first mistake of my career by the training of well-meaning relatives. I do not know how to describe this mistake by a single word, but it consisted in the feeling whenever I failed to succeed that it was because some one "had it in for me." I was taught that I stood no chance of securing employment with certain firms and corporations for the alleged reason that the head of those firms in youth had been lower in the social scale than my parents and, living in the same town, had hated them and would take it out on their descendants.

This bred in me the belief that whenever my work was not appreciated, it was due to jealousy somewhere. I fear that I spent more time trying to think up causes for my superior officers being jealous than I did in trying to find out if I had not been at fault. This developed a brooding inclination which tended to make me an unlovable person. But for the intervention of Providence through the means of a revival in a church in the city in which I was staying, and the meeting of a manly Christian gentleman, my failure in life might have been absolute, and characterized by a stronger word than is used at the head of this article.

While serving as axeman and rear chainman on a railroad survey, whenever I received a "call down" I attributed it to my superior having "it in for me," and so my moroseness increased. When serving as rodman on city work, I imagined the City Engineer was "down on me," and one day when he failed to back up my ruling on some masonry in a culvert, I quit in a huff. The affair is clear to me now, but then I could not see it. I was carrying out the specifications; the contractor appealed to the City Engineer and he supported me. The contractor then went to the aldermen from that ward, and after a long talk of the four, two aldermen, the contractor and the engineer, I was ordered to allow the change.

Now the City Engineer was the responsible person; it was no reflection on me if he decided to change the conditions. But I felt then that he had repudiated me, and "had it in for me," and so I quit. Very fortunately for me, however, I got employment soon afterward under a fine manly fellow who bore with me patiently, and under his kindly tutelage my disposition greatly improved. I think this was the best thing that ever happened to me.

My second great mistake had far-reaching consequences. It was so fatal to my success as an engineer that I find it difficult to admit it even now. Indeed it is hard, after many bitter experiences, not to feel that I would have met some reverse had I not made that unfortunate change.

I was one of two young men employed on the work of constructing the first cable street railway in Chicago. I was receiving $65 per month. Living in Chicago was to my country-boy outlook very expensive. I was the main dependence of a mother and three sisters. Country people lived cheaply, and $35 per month kept them, but I found the remaining $30 very little to live on in Chicago. At this time, I was offered a position with one of the railways entering Chicago as levelman on location and took it. I was to be paid $85 per month and all my expenses. I jumped at the chance and thought myself very lucky. The logic of events seems to indicate otherwise.

The other young man, who was my associate at that time, remained to the end of that job. He was given more responsibility and better pay on the next street in which the cable road was built. After that he went to Washington as Principal Assistant Engineer, and then to New York, where, upon the death of the Chief Engineer at about the time the Broadway cable was completed, he became Chief on the Columbus Ave. line. Later he advanced to become Chief Engineer and finally General Manager of an elevated road in Chicago.

It seems to me as I look back that at the time we were together, I stood better with the Chief than he, and that my chance of advancement was the better. It is difficult for a young man to make a wise choice at such a time. I do not look back on this now with regret. I know I made an error of judgment, but it was made in good faith, and I was envied by the other man at the time.

It is hard to advise what a young engineer ought to do in such situations. For instance, suppose there are two railways wanting young men for construction work and one pays $110 for a locating engineer, $75 for a transitman and $60 for a levelman, while the other pays $150, $100 and $85 for the same positions. Generally speaking, the road paying the better wages will have the better class of men, surroundings will be the pleasanter, and the chance for learning will be the better. I feel that it is usually best to go with the company which pays best when the work is of the same class.

The difficulty comes when one must choose between a class of work calling for a long period of tutelage in a position of meager salary and one paying a liberal salary at the beginning. One must realize that the position into which you can jump at once with a liberal salary, is one into which some other fellow can later jump just as easily and that it is possibly a position in which the employer likes to use young men. It is probable that the young man of to-day who takes up cement, reinforced-concrete or hydro-electric work and the like can build for himself a position which will make his mature years most pleasant. He may be required to work at first for wages which will deprive him of much which makes life enjoyable, but he will probably reap the reward later.

Now I know that there is nothing cheaper than so-called "good advice," unless it be Canada thistles or Johnson grass. Which of the three will do the most good is likewise problematical. So it is with doubt and hesitation that the above is written.

My third mistake grew largely out of the first. After leaving my position with the cable railroad, I went to work for a railroad company with which I remained five years. I lost no time during these years, and my pay was advanced until I was receiving $100 per month and all expenses. About this time I was a member of a locating party sent to make the survey from the south across the dividing ridge toward Lake Superior, and meet another party which was sent to make the corresponding location from the shores of Lake Superior south. Our party was made up of thoroughly seasoned men, and we were accustomed to the woods, to the country and to the weather. The other party did many things which we thought effeminate. The result was that we accomplished about double the mileage which this larger party did.

When the work was over we learned that the members of the other party were paid more salary in each position than we were. Our feeling of resentment was further roused by the fact that the other party was made up of college men and sons of prominent men. We left the service of the road. I have since been told by the Chief of the other party, who later became Chief Engineer of the road, that he held the highest regard for the men in our party, and that one of his regrets, when he was later made Chief Engineer of the road, was that we were not there to fill positions for which he needed us. One man who was in the field party with me a few years previous is now General Manager of the road.

There was one thing which I had been wise enough to do. On beginning my work with this railroad, I bought such engineering works as were then available, and sought to keep informed as to the work of men higher up. I also cultivated the acquaintance of such men as I could in other departments. This gave me a broader understanding of the work of engineering than some of my fellows. It several times helped me to secure work and get better assignments.

After leaving the railway last mentioned, I secured a position with a transcontinental line. The salary was better than the one I had left. After two years service here I changed to another line, a mountain road, where I remained four years. Here I was promoted to a position called "Assistant to the General Superintendent and Chief Engineer." This I held until a change of management brought an end to the dual office, and my job was abolished.

I was fortunate enough, however, to be able to secure, through the efforts of our former General Superintendent and Chief Engineer, the appointment as Superintendent of a 400-mile division on a Southern railway.

It was a line built extravagantly with an eye to low grades and through traffic, but the terminals were wholly insufficient for the traffic that it must handle if it were to live. It had recently avoided a receivership by the intervention of a strong financier, who had named a satellite as President. The President had named a General Superintendent. The General Manager was a hold-over. Between these three there was little short of open warfare. There was hardly a semblance of discipline on the road; it was when the "A. P. A." movement was strong, and it was believed that the President was in sympathy with that movement, and it was also believed the General Manager was a Catholic. The feeling was widespread among officials and employes, that if you were a Catholic the President would "get you," and on the other hand the General Manager would if you were not.

I was told that my predecessor was dismissed because he did not keep the yard at the division headquarters open. The city where this yard was located was also the capital of the state, and politics were hot over the readjustment of the state debt. It was the time when the "Switchmen's Mutual Aid" was a strong and most aggressive order. It was a good patron of saloons and saloons were not without political influence.

My first night as Superintendent was largely spent on a couch in the office, with several trips through the yard. Each time I found half the switch engines with a curtain over the headlight and deserted by the crew. I left a memorandum of my findings in an envelope addressed to the night yardmaster before going to bed. I also asked him to come to my office next afternoon.

Meanwhile I looked over the available men for a successor. I picked out as suitable a stocky, heavy-jawed man who was in the freight service.

When I saw the yardmaster, I realized why he did not succeed. We had a talk, and I decided to give him one more night, so he would be thoroughly sick of the job. That second night was a repetition of the first, except that they delayed a mail train. Next day I informed the yardmaster that he was placed back at the top of the list of freight conductors, where he stood when given the yard. I put the other fellow on the gridiron a while and tried to impress on him that I believed he could handle the yard if he would try, but that I feared he would most likely try to stand in with the men. He left me with a set jaw which made me think he would come very near to running things in the yard. The caboose track was near the office building, and the switchmen, on finding a new yardmaster in charge, left in a body, each man smashing his lantern against a caboose as he came by, and depositing the wreck on the porch as he came in.

Little work was done that night except to get the passenger trains and perishable freight through. Vigorous wiring brought a few non-union switchmen from Baltimore on the morning train, more from Philadelphia at noon and more from New York by night. The old switchmen were unsuccessful in getting engineers and firemen to refuse to work with the recruits, but with the politicians they were more successful. We were harassed by daily orders from the city police and the State Railroad Commission. Many of these orders called for work which I could not do without authority from the General Manager, whose office was at the western end of the road, as was the President's.

It was daily intimated, often more broadly than by mere intimation, that I was not showing proper care of the diplomatic end of my duties, else these orders would not be issued.

I was working hard, trying to get order on the division, harassed by the lack of cooperation between the General Manager and the General Superintendent, unable to get proper response to my letters and telegrams, and in continual dread lest some friction develop with one of the strong and more conservative brotherhoods. My nerves were tense and my temper worn to a frazzle. My trainmaster was taken down with summer sickness, my chief dispatcher at headquarters was half-sick, and I myself heartily wished I was back in the mountains.

The General Superintendent's chief clerk was a little light for the job, and caused me much anxiety by passing on matters of discipline without examination. A train crew ran by green and red flags, and the Chief Clerk wired a restoration to duty for them in the Superintendent's name.

While all this was wearing me out, a collision occurred between a special train carrying the directors and a milk train. I could have cleared myself of all responsibility for the accident and held my place, had I been able to use a little diplomacy. But I lost my head, abused the General Superintendent for breaking my attempts at discipline, for his interference with division matters, and ended by calling him a liar and trying to hit him at the investigation. So ended my career in the operating department.

In its consequence, this was the most serious mistake I had made, for it barred me from railroad service for the time. I was then 38 years of age; married; out of a job; blacklisted! Failure was then spelled with big black capital letters. Naturally, I was very much down-hearted. But I met an old acquaintance, a contractor, who offered me a very good chance with him. In brief, it was a salary equal to what I had received from the railroad and an interest in any work which I handled or secured for the firm.

The first job which I handled as a contractor was a rock cut. I built a lateral from an irrigation ditch to the high ground above the cut and after shooting the rock, I turned in the water, washing away the debris. It was done at about the cost of an earth cut, and I was very jubilant over my first work.

The second job was an irrigation canal where I brought my engineering knowledge into use in excavating the wet material and this work was also highly successful. My percentage from that year's work was about $9,000 above my salary.

My second year's work was also successful so far as handling the work went. But through a financial stringency the company for which we were working was tied up, and could not pay us. Thus our losses as a firm exceeded our profits. We had a lien, and it was thought we would secure the money before long.

The third year found us at its end with a claim amounting to $280,000 against a railroad which had gone into hands of a receiver. About the same time our senior member became disheartened over private affairs, and shot himself. We went to the bad very fast. Our company was a total failure; our assets were never realized on; our machinery and stock had no value, as there was no work where they could be used. We were operating the road we had built, trying to save ourselves, and one night I was mashed up in an accident and put out of service for many months.

Contracting showed me another lack of fitness in not having a business training. Good business foresight on my part would have enabled me to keep out of the disasters which carried us down. I had found that successful contracting is as much dependent on the business end as it is on the engineering end. When our head became engrossed in outside affairs and gave little attention to the business and financial affairs of the company, the partner left in charge of that part fell down, and disaster resulted. Most engineers venturing into the contracting field succeed, so far as handling the work well, and correctly figuring the costs go. They often fail, as I did, from the lack of business sense. What is business acumen? Not possessing it, I cannot describe it.

We were successful as a firm in everything except the vital one of getting pay for what we had done. In two years we had done work for which we were to have received over $300,000 and for which we received nothing. On each job there was a time when we could have gotten out without loss, and even with some profit. In each case it would have involved our laying down. Through failing to fulfill our part of the contract we would have been called very hard names, but perhaps the resulting profit might have fortified us to stand the denunciation of those who knew they could never pay us.

It is sometimes necessary to look ahead and to demand of the corporation for which you are doing the work, that it do more than pay you when an estimate comes around. It may be that you will have to demand that they show you how the coming estimate is going to be paid. The fact that they have 50 miles of road in operation and a contract with a brokerage house to take their bonds as each ten miles is completed, is all well enough so far as it goes. But you must go deeper. You must find if that contract can be enforced against the brokerage house, and then if that house can make good. Had we done this, the writer might not now be writing "unsuccessful" after his name.

Probably a smaller percentage of engineers fail as contractors than do men going into that business from other channels, and their failures are less excusable. They know how to avoid them if they will only use business sense.

After my unsuccessful career as a contractor had closed, I secured a position with an old engineer friend to make an examination of a number of roads and report on the cost of reproducing them, and also on the cost of rehabilitating them, on supplying the facilities to enable them to meet competition, etc. This took several months, and after it was done it appeared to me that I had at last found a niche into which I could fit.

I rented an office in Chicago, fitted it up, had stationery printed, hired a stenographer, arranged for desk room and mail to be sent care of an office on lower Broadway in New York, and became a Consulting Engineer. I had good acquaintances, I thought, in all the larger cities in this country and in London. In seven months' time my gross income was $15, which was paid me for giving expert testimony in a suit between one of the elevated roads and one of the surface street-railways of Chicago.

I found then the men who were secur[ed] the expert work were very largely men wh[o] were either stockholders in some of the large[st] companies or closely related either by b[lood] or former business affiliations with the ex[ec]utive officers of such companies. My reference[s] the presidents of three of the large railway s[ys]tems, to several chief engineers and to two [Un]ited States senators were not the sort which [ca]n do business. I kept up a wide correspondenc[e] met many men of business, entertained them [at] the club to which I had gained admission, sp[ent] the money I had saved, and then was for[ced] to abandon the field. The chance for an en[gi]neer who depended simply on his standing as [an] engineer to succeed in a large city as a Cons[ul]ting Engineer seemed to me very near what is usually represented by a cipher.

Now I realize that there were a number of engineers, fully as capable as I, who went the same way. For two successive months I paid office rent for two engineers, one in New York and one in Chicago, and they walked to and from their offices, blacked their own boots, brushed their own clothes, ate no lunch and how they lived uptown I can only guess.

About this time an incident occurred which made a deep impression on me. When I had been a young man, and before I was trusted to handle an instrument, I came to know and to revere an engineer much older than I, who was Office Engineer for the large railroad system for which I worked so many years. He seemed, to my boyish mind, to be the embodiment of engineering wisdom. No question ever came up in the office which he could not answer off-hand. He knew who had made every survey, what each section of the road had cost, what outfit a party needed anywhere on the road, the advantages and defect of each make of instrument, how to work any problem, and it seemed to me that if I ever got to know as much as he did, my ambition would be realized.

After my years in the West, when I returned to Chicago I went to the office and asked for him. He was not there and no one knew where he was. The new Chief Engineer had made many changes, and the old man had found it uncongenial and had left. I learned later that he had ventured into business and had met with disaster. At the time of my last venture, I saw an item in one of the daily papers announcing his death the preceding night. He was then living in a Clark St. lodging house and working at some shop, running a bolt cutter for $1.12½ per day. As I thought of his death, alone, deserted by his family, lost to his old time friends, among the human derelicts, I realized how great must have been his misery in those last days.

After I had given up hope of a living as an independent engineer, I secured a position with a railway promoter, an attorney and an ex-judge, to act as Chief Engineer for his project. He was a very domineering man, had no knowledge of railroad economics and was too egotistical to realize his lack of knowledge. I made his surveys, changed the line from favorable to outrageous location, committed all sorts of sins from an economic standpoint, did anything which would save the cost of right-of-way or enhance the value of a tract of land in which he might have an interest. I took his orders and carried them out, was a mere instrumentman or a messenger between him and the instrumentman. Then, after he had secured all the donations possible, he sold out to a large line. I was continued as Chief Engineer. The Chief Engineer of the large line was one of the Directors, and I was told to receive my orders from him. He looked over map and profile, gave me quite a number of general directions, and some particular ones. I ventured to inform him that these changes would increase cost, and that directions had been to keep cost down. He said he would take care of that. Thus the line was bettered from an engineering standpoint and construction went on. When the grading was half done there was an explosion. The cost was mounting up. The Judge had the ear of the Board of Directors, and the Chief Engineer was given to understand that the man must be listened to. I was discharged in much disgrace.

Many loud words were used. Later, the Chief Engineer apologized to me, and explained the predicament, but this did not put me back on the job nor make up for lost salary and injury done to my standing in that locality. This event has been a puzzle to me. If I had consulted the Judge and continued as an automaton would not the Chief Engineer have fired me for disobedience? What is the key to success in working for an egotist?

My next position was with a line of considerable extent. I went out as transitman on maintenance-of-way. Six months later I was promoted to Assistant Engineer. Within a year I was made Acting Roadmaster and for a time Acting Resident Engineer, in charge of three roadmasters' districts. Upon the return of these officers to their duties I was given title of "Engineer in Charge" and placed in charge of masonry construction, handling labor direct in order to get along with labor unions. A union bricklayer cannot work under a non-union foreman, but he can work under orders of the Architect and an engineer here classes as an architect.

Some time later the work was closed down owing to the death of the President and to the uncertainty of the future. The only job for me was foreman of a pile driver. I shrank from this job, not because I was unwilling to come down to it, but I was unable to successfully splice a rope and knew that, under these conditions, there would always be one man on the job who would have me at his mercy. So I went to another road as Assistant Engineer. Had I stayed with the pile driver it would not have been 60 days until a permanent position as Assistant Engineer would have been open to me. It was less than a year before this Assistant Engineer was made Roadmaster, less than six months more before he was made Resident Engineer, and within two years he was Division Superintendent, and is now General Manager of one of the subsidiary roads. All the men who were then in my grade and remained with the road have landed in good positions. I have felt this mistake more than all others, for here was a system with sound organization and little interference between departments.

This last position I have mentioned was a good one and lasted for three years. From it I went to a position as Superintendent of Construction for a road of 1,500 miles extent. After a year in that position, I was made Resident Engineer, in charge of maintenance-of-way for about half the road. I was well liked here by all, and but for an unfortunate incident I would still be with that line. I have always much regretted this, but I can not see how it could have been avoided.

A steam shovel was ordered moved from the shops to a point where it was needed. The order to move was given on Sunday and there were no men at the shops to make it ready for moving. The conductor was ordered to move it, and exercise care. The projecting boom wrecked the upper members of a bridge, and destroyed the structure, making a bad wreck. The road had just replaced a bridge of about the same length on one of the branches with a heavier structure to accommodate the heavy engines which were necessary for the heavy grades of the branch and its coal traffic. The superintendent ordered me to take measurements and to make plans for abutments so we could use this discarded bridge on the main line. I went to the place where the bridge lay, made an examination and measurements, and reported verbally that I did not think the bridge strong enough for the traffic of the line. He said curtly that we would use the bridge.

Later one of the other officers, in a private talk on a sleeping car, asked me if I thought the bridge was strong enough for the place it was being moved to, and I said that I did not. Some weeks later I was called to the Superintendent's office to see the General Manager. When I went in he asked me if I had told Mr. Blank that the bridge was too weak. I tried to explain that this was said in a private talk, and was not a report. He grew stern, and told me that if I thought that, it was my duty to report the matter to the Superintendent. I referred him to that gentleman, who was present and who said that I had given him my opinion to that effect. The Manager ordered a bridge engineer to examine the bridge and to make a report. The bridge was not used, but within three months a change was made by which the executive duties of the Resident Engineer were transferred to the Roadmaster, the other duties to an Assistant Engineer, reporting to the Roadmaster, and the Resident Engineer's job abolished. Many regrets but no place for me! My mistake was in expecting a fellow-employee to honor my confidence. It was impressed on me that silence was golden, and that it was a crime to know anything or report anything save to your immediate superior.

A few months after losing my place owing to the bridge incident, I secured another place with a large system as Assistant Engineer. After some general assignments I had a part in the reorganization of the system, and was made Division Engineer in charge of maintenance-of-way. I held this job for about a year and a half, after which I was advanced to the position of Division Superintendent. In this position I soon learned there was much friction higher up.

There was, it seemed, a tacit understanding in the General Manager's office that the Division Superintendents were to be named alternately by the Engineer of Maintenance of Way and the General Superintendent. He reported on matters of operation to the General Superintendent, on matters of maintenance-of-way to the Engineer of Maintenance of Way, and on matters of equipment to the Superintendent of Motive Power and Equipment.

This position was one of much worry. There were conditions which I could not seem to get the run of. It was difficult to get authority to do necessary work. For instance, the drainage of the shops was cared for by a drain discharging on a plot of low ground, the surrounding property being occupied by dwellings. The people living there had petitioned for relief, and were met with promises which were not fulfilled. The City Council took up the matter, and I had an interview, and got them to withhold action until I could get word from headquarters. Meanwhile, the hot weather passed and the matter was not pushed. Then the drainage of a pond on our property near the shops was needed to prevent the creation of a nuisance. All these things I had placed before those higher up with a plain statement of the position we would be in were something not done. This was fortified by a letter from the local attorney for the road stating that we would have no defense in a damage suit were one brought. A plan was devised by which we were permitted to utilize some existing works if no fuss were made, and by using these a great saving in cost would be made.

Things drifted on. Meanwhile I tried to better our labor conditions by bringing in foreigners to take the place of negroes. As the negroes used to spend all their money at the stores, a little before it was earned, and as the foreigners spent but little, I soon felt the wrath of one of the most exacting trusts in the South, the retail merchants association. Now all Southern states have rigid laws against gambling and Sunday labor, but my foreigners simply would play their native games and wash their clothes on Sunday. The result was a raid by the local constables, and my men were found guilty of both charges in a local justice court and fined about $25 each, counting the fees of justice, constable and prosecuting attorney. It took all sorts of work from us to get this straightened out.

Then about this time trouble began brewing in the shops. Orders were given to lay off the men for the last half of the month. The motive power became unreliable. When the shops opened there was more difficulty and we soon had a lockout. The Mayor and prominent people tried to adjust the matter, but there seemed no ground on which an agreement could be reached. Maintenance-of-way forces had also been reduced, and the track was getting less safe. Then came the effort of a rival road to take the mail contract away from us. We were ordered to speed up the mail train; all this, remember, with the maintenance forces reduced and the shops closed.

While I was worrying over this there came an order from the City Council, who felt that their efforts to settle the troubles of the shop men had not been respectfully treated by the higher officials, for us to cease at once to discharge the shop drainage into the vacant lot. This was made a health order, and its disobedience was subject to very severe penalties. The best I could get from the Mayor was a verbal promise that if we began, with an adequate force, to build an outlet he would not enforce the penalties. However, he would not withdraw the order. Within five days came an order from the same body to drain the pond. Almost immediately came an order from the State Railroad Commission that we open a blocked crossing of a highway, and that we pay some attention to orders for station buildings which that body had previously ordered.

The attorney and I went before the board and made a plea, getting from them a little concession. If we would open the highway within 30 days and would get station buildings within 90 days, they would not inflict penalties. We passed these up to the higher authorities with a statement of the Commission's power. I was then authorized to carry out the drainage of the shops, using the existing drainage works of other property holders. As was to be expected, some sympathizer of the locked-out shopmen got us into trouble with the owners and we were forbidden to use it. This had been handled outside my office, and no diplomacy shown. Still, the blame came to me. It doubled the cost of the work, and there was wrath clear to the New York office.

Then came a reminder from the Railroad Commission, that the crossing was not being opened, with a warning. Our attorney advised me, and also advised the General Counsel that it would bring on very serious complications if we did not open the crossing. I had no reply to my urgent letters and telegrams. I got a long-distance telephone connection with the office of Engineer of Maintenance of Way and his clerk told me that both he and the General Manager were in Chicago, where there was trouble with the Inter-state Commerce Commission over some ruling. I then got the General Manager's office, and explained the conditions to the Chief Clerk, and urged him to get word to the General Manager in Chicago. I went to see the attorney again, and got him to call up the General Counsel, and see if we could not get some advice. All we got from him was that the crossing must be opened.

Next day, as I could get no word from the General Manager or the Engineer of Maintenance of Way, I got out an extra gang, and opened the crossing. The same day I received a peremptory order from the Mayor about the drainage of the pond. It named the penalties which had then accrued. The next day the fast mail went into the ditch, and to make it worse, went in at the point where the extra gang had been working which I had taken away to open the crossing. The engineer, fireman and two mail clerks were killed, and others were badly injured.

I was satisfied, as were all who were on the ground, that the accident was caused by a defect in the engine and that such defect had been reported. But the engineer was dead, and the record could not be found. I was relieved and told that my unauthorized removal of the extra gang was responsible for the wreck, and that my carelessness had allowed the situation to become so bad that the orders from the Council and Commission were the result!

So ended my second position as Superintendent. It seems that I was not big enough to foresee unfavorable conditions, and to successfully put the blame for what did happen on some one else. I have tried to state it fairly. It may be well to state here that when rolling stock became badly out of repair, a large amount was repaired at outside shops. This helped a showing for the road in two ways. The operating department was credited with the haul on the equipment, and the extra cost made a good showing for the road in its maintenance; showed they

were keeping up their engines and cars to a high standard!

Well, now I am back as an engineer again, with a minor road. At this time it seems that I have the confidence of my superiors, the respect of my subordinates and the regard of my associates in the management. My failures, as the reader will note, have not been from lack of engineering knowledge. I seem to lack diplomacy in dealing with those in authority. If these confessions should help some man to avoid the pitfalls into which I have fallen at various times, the object for which I have written these reminiscences will have been accomplished.

Diamond-Drill Borings for a Dam on the Clackamas River (Oregon.)*

The Portland Railway, Light & Power Co., of Portland, Ore., operates a large hydro-electric power plant at Oregon City, on the Willamette River, 14 miles above Portland; and a similar plant at Cazadero, on the Clackamas River, 35 miles above Portland. Last year the company decided on the immediate construction of two more power plants on the Clackamas River. For these two plants, four sites were available. Three of these

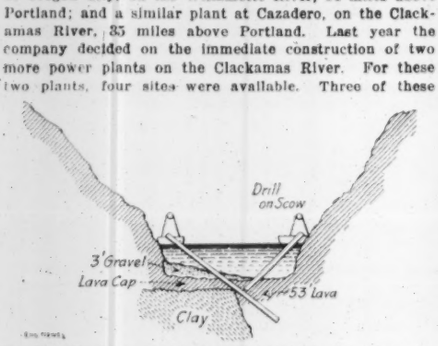


Fig. 1. Borings at Proposed Site (B) for Dam in the Clackamas River; Oregon.

were about 3½ miles below the Cazadero plant, and were designated as sites (A), (B) and (C). The fourth was above the present plant and known as site (D).

The prevailing formation of the country is volcanic, consisting of hard lava caps and boulders, cemented with volcanic ash, underlaid with clay or gravel, and full of seams, holes and fissures. Time was a most essential item, as all tests must be completed and the power site chosen so that actual construction work might be got well under way during the low-water season of 1910. It was decided to use diamond core drills to thoroughly prospect the ground at each site.

In December, 1909, the company let a contract to the Sullivan Machinery Co., of Chicago, to do this work. Drilling was begun the latter part of January, 1910. Two screw feed "Badger" drills were placed on the work in charge of one foreman, with four runners and four helpers. The drills were operated two shifts each, the day shift being 60 hours per week, and the night shift 55 hours per week. A drilling crew consisted of a runner and two helpers per machine.

It required but two holes to show that site (A) was unsuitable. The formation was a decomposed volcanic ash, broken, soft and full of fissures. Site (B), a short distance below, proved to have some advantages as far as formation and foundation material were concerned. Disadvantages for plant location caused its abandonment. It did not afford room for a spillway of sufficient length to keep up the required head during the low-water period, and would have necessitated the installation of flash boards at the low-water season and their removal during high water, to prevent raising the back water into the Cazadero plant above.

Six holes were put in at site (B). The water was about 5 ft. deep, flowing about 6 m. p. h. A scow was built, floated to position, wedged from below and loaded with rock so that it would rest solidly on the cribbing. An anchor-rope was also used to hold the scow in position. Two of the holes crossed each other about midstream, approximately 50 ft. below the surface, as shown in Fig. 1.

In some places the formation was so soft and broken that it was impossible to use the ordinary core barrel, because the water pressure alone would cause the broken particles to press down on the working face and grind up the core. The standard core barrel was replaced with a Sullivan special double tube core barrel, such as is employed in coal prospecting. This held the core in place, and enabled from 60 to 90% to be recovered.

At site (C), just below site (B), an island in the middle of the river forms a natural key for the dam as shown in Fig. 2. The water was 6 ft. deep, running about 12 m. p. h. In the left channel two holes were drilled, one from cribbing over the water and one from a large boulder on which the drill was mounted. In both instances casing was drilled into the hole and sealed in the bed rock. In the right-hand channel two holes were also put in, the drilling being done from cribbing and from a boulder. In this case, the boulder was penetrated and the bed rock underlying then entered.

On the river bank open pits were dug to bed rock, and in certain places, churn drill holes were sunk to the lava cap, and diamond drilling then proceeded in the regular way. The drilling at site (C) consisted of three vertical holes in the island; two holes in each channel of the river, and 21 holes on the river banks.

The moving of the drilling equipment to the island was very difficult, as all material and equipment had to be taken across on wire ropes. An extra boiler plant was necessary to supply water to the island for the drill boiler and for the drill.

At site (D), 1½ miles above the present Cazadero plant, the surface gravel and overburden were washed off with a hydraulic giant, the stream being furnished by a four-stage centrifugal pump driven by a 200-HP. motor, mounted on a scow in the river. A strip 50 ft. wide was cleared off to the bed rock to a height of 150 ft. on the bank. Two parallel rows of holes were put down, the holes being spaced 25 ft. apart and the rows 40 ft. apart, with holes staggered, as shown in Fig. 3.

Pressure determinations were made in each hole at 50 and 75 ft. to ascertain the porosity of the rock. A short piece of pipe is left sealed in the top of each hole and cement grout will be pumped into each hole under high pressure, as at site (C) and as described below.

Three holes have been drilled in the river bed at site (D), the water being 5 ft. deep and the flow 10 m. p. h. At this point, drive pipe had to be put down through 23 ft. of gravel and boulders. An ordinary cross chopping bit was used inside the drive pipe and where large boulders were prevalent, four to five shots of dynamite were often needed to advance the drive pipe through

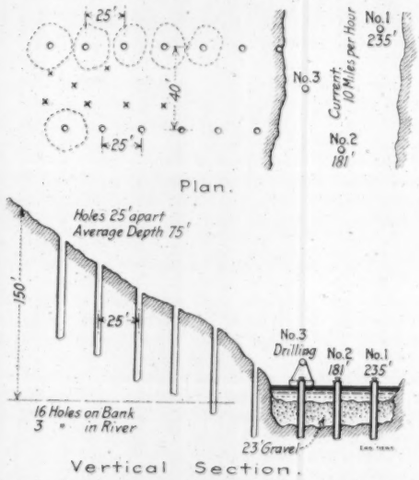


Fig. 2. Plan and Section of Borings at Site (C) for a New Dam in the Clackamas River (Oregon) for the Portland Railway, Light & Power Co.

the gravel. This work is now being done from a scow anchored with guy ropes and wedged from the river bed. Both the drill and boiler are mounted on the scow. The three holes in the river bed averaged over 200 ft. in depth. Fig. 4 shows the drilling rig in the river at this point.

Testing the river bed by means of pits in cofferdams was tried at first. The engineers were successful in sinking one pit to a depth of 20 ft. below the river bed. The second cofferdam, on which work was begun later in the season, was unsuccessful on account of the high water; it was therefore abandoned and a diamond drill employed. The engineer stated that the drilling proved to be much cheaper and quicker than the test pit method.

Sealing Porous Ground.

From the results of this drilling, site (C) was chosen as one of the two locations for the new dams. The solidity of the rock was determined by drilling holes 35 to 50 ft. deep, sealing the casing in the hole and putting 300 lbs. water pressure on the hole. The porosity of the rock was then observed by the amount of water flowing into the hole. The holes were then drilled to a further depth of 70 or 80 ft. and the water pressure again applied to note the increase in amount of flow. No increase of flow occurred below 40 ft. in depth, indicating solid rock beyond that point.

Automatic mixing cylinders, coupled to an air compressor, will be connected to each hole and cement pumped in under 300 lbs. pressure, thus filling up the interstices of the rock in both channels and preventing leakage below the dam.

The same plan will be followed at site (D). A center line of holes will then be put down between the holes already drilled (Fig. 3). If these new holes do not show that the cement has been forced out all through the rock, intermediate staggered holes will be put down and cement forced in under pressure until the whole body of rock is cemented firmly together. The idea is shown in Fig. 3 by the dotted lines around each hole, indicating the possible radius of flow of cement out into the rock.

A series of staggered holes will later be drilled in the river bed for introducing the cement grout under pressure, in the manner above described, but this will not be done until the 22 ft. of gravel is excavated from the river bed. This excavation will be done with a cable and scraper. If the holes were put in now with the pipes sealed into them, these pipes, sticking up through the gravel, would seriously interfere with the excavation.

The following additional information has been obtained as to the progress and method of work.

At the site for the lower or "river mill" dam (at Estacada), the width of the river is 240 ft. in the left channel and 160 ft. in the right channel. The depth of water is about 4 ft. in the former and 5 ft. in the latter channel. After the cofferdam was put in the left channel, a trench 6 ft. wide and 6 ft. deep was blasted in the rock of the river bed. After all the diamond-drill holes had been put in and tested with water from a high pressure pump (as described above) to test the cracks leading to the surface, this trench was filled with concrete, leaving the drill casing pipes protruding. This concrete was allowed to set before the work of grouting the holes was begun.

The drill holes were arranged in three rows (staggered); they were 6 ft. apart and 50 ft. deep. They were tested at a depth of 20 ft. and again at 50 ft., the tests being made on each group of five. The four corner holes were grouted and allowed to set. Then the middle hole was tested with water under pressure, and if it proved watertight it was grouted. If there was leakage, two more holes were drilled between the corner holes. These were then grouted and if the center hole still leaked, two more holes were drilled (making three in each side, or nine in

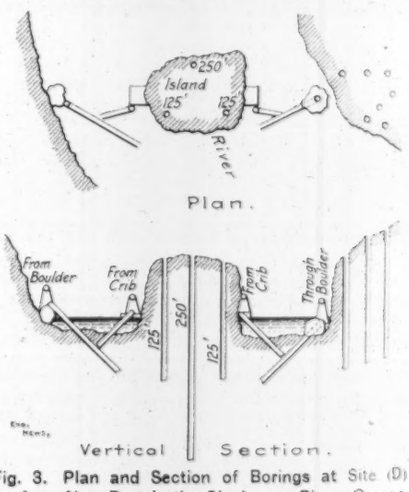


Fig. 3. Plan and Section of Borings at Site (D) for a New Dam in the Clackamas River; Oregon.

all) and tested until the center hole was found to be tight. Nearly 7,000 ft. of drilling was done in this channel.

When this work was completed, the river was diverted into the left channel. The engineers were unable therefore to determine how far the cement had traveled up or down-stream from the trench. This will be done next spring when the river is again diverted from the left channel.

The cofferdam in the right channel has been finished and the trench in which the drilling will be done is now being dug, as in the case of the left channel. The only diamond drilling done thus far at this channel is what was done last winter from cribbing. The dia-

*Slightly condensed and rearranged from a paper by Mr. V. J. Hampton in "Mines and Quarries" (published by the Sullivan Machinery Co., Chicago).

mond drills show the rock on the island to be too soft to form an integral part of the dam. The face of the island is now being removed (on a slope) to the water's edge, and a concrete shoe or face will be built across the end of the island.

The dam at the upper or second site will be about 750 ft. long on the crest. The diamond drills are now in use at this site. The ground is much harder there and has fewer cracks and fissures. There are still enough, however, to warrant the company in solidifying the foundation either by drilling and grouting or by building a cut-off wall. As the latter would be very expensive and would require a long time, the

FIG. 4. DRILLING RIG FOR DIAMOND-DRILL BORINGS IN THE CLACKAMAS RIVER (AT SITE D).

work will be done with the drill holes if possible. The exploratory holes at this site have not yet been finished. These are placed in three rows, the two outside rows 40 ft. apart, and the holes in each row 25 ft. apart, the holes of the inside row alternating with those in the two outside rows.

The small amount of grouting done here was not satisfactory at first. Seven holes were then drilled in a circle and one in the center. These were tested with water pressure from tanks on the mountain side, giving 200 lbs. pressure. The holes were then grouted and a large quantity of cement forced into them. The cement appeared through cracks on the surface 35 ft. away from the holes, it proving necessary to drill the holes very close together to give the proper vent for the air which precedes the cement grouting into the holes. This air seems to act as a cushion to prevent the grout from finding its way to a satisfactory distance from the holes.

For information and drawings we are indebted to the Sullivan Machinery Co., of Chicago. Mr. O. B. Coldwell is General Superintendent of the Light and Power Department of the Portland Railway, Light & Power Co. The construction work on the dams is in charge of Sellers & Rippey, consulting engineers, Philadelphia, Pa.

American Good Roads Congress.

The seventh annual convention of the American Road Builders' Association was held at Indianapolis, Ind., Dec. 6-9, 1910. The Congress was attended by delegates from 39 states of the Union and four provinces of Canada. The registration showed an attendance of about 1,500. Delegates came from every point from Washington, D. C., to Washington on the Pacific Coast, from New York to Florida and California. The regular sessions of the Congress were held in the German House, where a good-sized auditorium was available.

Many exhibits were made by manufacturers of road machinery, tools and appliances. In the main exhibition hall of the German House numerous booths were occupied by exhibits. Two national associations of paving material manufacturers were represented among the exhibitors. Purdue University had an exhibit which comprised several of the machines used in testing building materials. Several firms manufacturing culverts had exhibits, and a leading cement company had an attractive display. On the stage a moving picture show was given, showing views of road construction and the machinery used. In the summer garden adjoining the building were several exhibits of road rollers, traction engines, concrete mixers, road machinery, dump wagons, etc.

The delegates were officially welcomed at the first session of the Congress by Governor Marshall for the state, Mayor Shank for the city and C. A. Kenyon, Chairman of the Indiana Good Roads Association.

The Governor emphasized the importance of the good roads movement. He advocated a revision of the road laws of Indiana, and the adoption of a system requiring payment of the road tax in cash.

Mr. Kenyon reviewed the history of the Indiana Good Roads Association and assured the delegates that their presence was doubly welcome just at this time when Indiana was trying to solve the problem of how to get better roads.

In responding to the welcome, James H. MacDonald, President of the Congress, said the meeting would prove to be the most notable gathering in the interest of good roads that had ever been held in this country. He asserted that the attendance was larger than ever before at a first session of the Congress.

At the afternoon session of the Congress, on Dec. 6, a paper by L. W. Page, Director of the U. S. Office of Public Roads, was read by J. E. Pennypacker, Chief Assistant, Office of Public Roads. The paper is entitled "State Highway Legislation"; it comprises what Mr. Page considers the fundamental principles of a good state highway law. The bill proposed, provides for an unpaid state highway commission, non-partisan and technically competent. The actual work of the state highway department would be, however, under the direction of a civil engineer with full authority in all executive work of the department.

The initiative in obtaining state aid would rest with the county or local authorities. In the case of trunk line roads, the state should pay the entire cost and have full charge of the work. No state aid should be granted to counties until the application of the local authorities has been approved by the state highway engineer. All money expended by the state in road construction should be in pursuance of a plan looking to the ultimate establishment of a system of state roads.

Mr. Pennypacker emphasized the necessity of road maintenance after a road has once been constructed, and, in applying the provisions of the model bill to the campaign in Indiana, particularly pointed out that especial provision is made for the careful maintenance of highways in this bill.

H. S. Earle, ex-State Highway Commissioner of Michigan, told of the work being done in Wayne County, Michigan, in building 250 miles of fine roads radiating in all directions from Detroit. These roads have a concrete surface.

F. J. Robinson, Deputy Minister of Public Works, Province of Saskatchewan, Canada, read a paper on "Pioneer Road Making in Saskatchewan."

Joseph W. Hunter, State Highway Commissioner of Pennsylvania, read a paper on the "Application of the Highway Law of Pennsylvania." In the course of his talk he explained the construction of some roads in Pennsylvania on which $18,000 a mile is being spent.

Samuel Hill, of Seattle, Wash., addressed the congress on the subject of convict labor for road construction. He said that through his efforts this has been tried with great success in the State of Washington. He advocated the construction by the National Government of a highway from Walla Walla, Wash., to Omaha, Neb., to be called the "Marcus Whitman Way" in honor of the famous pioneer. He declared that the question of good roads is one in comparison to which the tariff question and the building of the Panama Canal are mere jokes.

Charles P. Light, Commissioner of Roads of West Virginia, spoke on "Earth Roads." Any man with a plow and a split log drag, said he, can make a splendid dirt road, if he will keep at work on it. He said that dirt roads cannot be given a hard surface so that they are good for hauling all the year round, but they can be made fine roads for nine months of the year. He advocated the construction of dirt roads as one of the first and most important steps in obtaining better roads later.

Samuel H. Lea, State Engineer of South Dakota, read a paper on "Highways of the Northwest." He said the next South Dakota Legislature will pass a good roads law and that men of that state interested in good roads are going to see that it is the right kind of a law. He advocated state supervision of road construction as a solution of the road building problem. In his paper Mr. Lea reviewed the road history of the Northwest. He told of the care taken to maintain the roadways which were the first paths through the West and urged that road maintenance should receive more attention.

T. R. Atkinson, State Engineer of North Dakota, read a paper on the "Progress of the Good Roads Movement in North Dakota."

The application to Indiana of the methods adopted by the State of Massachusetts in the building of good roads was urged by Harold Parker, Chairman of the Massachusetts State Highway Commission. Massachusetts was the second state to adopt the plan of supervising its roads by means of a state commission, and the results are held to have placed that state above any other in the Union in the matter of excellence of its highways. He said that Massachusetts has spent $9,000,000 in improving her highways, and that it is the best expenditure the state ever made. Mr. Parker spoke at length about the roads of his state built of gravel and stone and treated with special oils. He said that the advent of the automobile and the disintegrating effect it has on the ordinary macadam road has made it necessary to discover new methods of road building.

At the close of Mr. Parker's address he was asked what effect a traction engine would have on such roads. He replied, "Nothing would be more serious," and advised keeping them off. He was told that Indiana was a wheat state and it would be impossible to move all the threshers except over the highways. Mr. Parker admitted that under such circumstances he would not advise the use of the oil preparation in Indiana.

James C. Wonders, State Highway Commissioner of Ohio, read a paper on "Present Highway Laws of Ohio and the Proposed New Law." He said the present laws are the result of more than 100 years of legislation, and that at the next session of the legislature another law is to be offered in an attempt to simplify the present road laws and to include points that have been demonstrated by experience to be of value. He said that Ohio has 14,168 miles of gravel roads, 9,687 miles of macadam and 231 miles of brick road under state control.

W. S. Gearhart, State Highway Engineer of Kansas, spoke of "Bridge and Culvert Construction." He advocated the use of concrete as much as practicable and deplored the continued use of wooden culverts in some parts of the country.

Paul D. Sargent, State Highway Engineer of Maine, read a paper on "What State Aid Has Done in Maine." He told of the work of improving Maine roads both under the old systems in use and since state aid was inaugurated. His address was intended to show the advantage in having competent men under the direction of the state officers to supervise the construction of roads.

A paper on "Progress of Road Building in Michigan" was read by Townsend A. Ely, State Highway Commissioner of Michigan. This paper described the unique method employed in that state to extend aid to counties in road building. Upon the completion of a road by any county, it is examined by the state commissioner, and, if approved, a bounty of so much a mile is granted by the state. For a properly constructed earth road the state returns to the county $250 a mile; for gravel $500 a mile, for asphalt surface $1,000 a mile, and so on according to a certain fixed schedule.

Outside of the regular program the delegates were entertained at several social functions in the way of banquets, receptions and drives around the city. A trip was taken in automobiles out to the Indianapolis Motor Speedway. A five-mile exhibition race had been planned but there was considerable snow and ice and the track was too slippery to permit it. Instead, a trip around the track was made by the delegates.

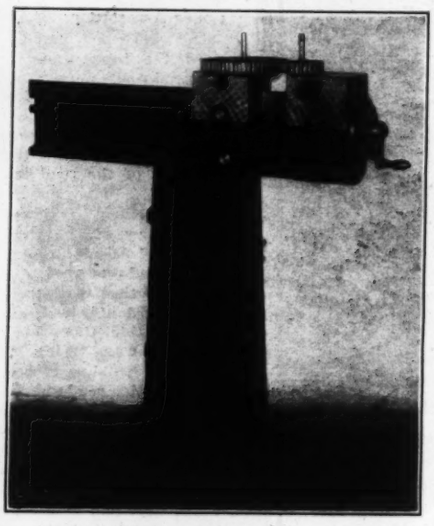
A Machine for Detecting Poorly Cut Gears.*

Improved methods for gear cutting, together with refinements in the accuracy of manufacture of gear-cutting machines, have brought about in recent years an increasingly extensive use of toothed gearing. Modern toothed gears show a good efficiency at speeds which were generally held to be altogether out of the question not many years ago. With the increased dependence on gear wheels, however, has come the necessity for some means of inspecting them easily and with sufficient thoroughness to detect any considerable irregularities. The machine shown in the accompanying half-tone has been designed for testing spur gears for inaccuracy in diameter, depth of teeth, clearance and center distances and for detecting skew teeth and gears cut eccentric with the bore.

The machine consists of a fixed head and a sliding head, the latter of which can be adjusted to any desired distance from the fixed head on a graduated rail. The fixed and sliding heads both carry arbors on which the gears to be tested can be mounted. The sliding head is moved along the graduated rail by means of a lead-screw turned by a hand-crank. By means of the graduations on the rail, the distance between centers of the arbors can be measured or can be set at any desired value. The rail is graduated in inches and tenths. The lead-screw carries a micrometer disk at the crank end which is graduated to read thousandths of an inch. A vernier block on the disk reads to quarter thousandths of an inch. The lead-screw is supported in the stationary head by a series of collars with angular sides running in split babbit nuts. Similar nuts in the sliding head grip the Acme thread of the screw. Thumb nuts are provided in the two heads, by means of which the babbit nuts on the screw thread and collar can be kept as tight and free from lost motion as is consistent with the free operation of the screw. Another thumb screw is provided for taking up lost motion between the sliding head and the rail. The crank handle is provided with a ratchet relief as a safety device to prevent injury to the machine or the gears.

In using the machine for testing center distances, the vertical arbors are used as shown in the illustration. The gears are placed on the arbors and brought together by moving the sliding head and are then moved apart by the amount of the desired clearance. The distance between the arbor centers should then be the center distance for which the gears are designed. By turning the gears by hand, with the center distance properly adjusted, any serious defects in individual teeth can be readily detected. A practical test for noise in operation may be made by placing the arbors in the horizontal sockets shown in the illustration on the sliding and fixed heads, and driving them by means of a belt with the center distance adjusted to the point where the gears run best.

Any error of measurement due to temperature or wear of the lead-screw can be detected by means of the 12-in. micrometer gage furnished with the machine, which is used as a check on the setting of the micrometer disk on the end of the screw. In making this check, the micrometer gage is used to measure the distance between the arbors, and comparison is made between the distance given by the micrometer gage and that given by the graduations on the rail and disk of the machine, making allowance for the diameter of the arbors used. On the back of the rail, not visible in the illustration, is a cast-iron shelf running its entire length, which is used to hold gages, arbors, bushings, etc., when the machine is being used. When the machine is not in use, these parts may be stored in the cabinet in the supporting column. The machine is known as the Farwell Gear Tester, and is manufactured by the Adams Co., of Dubuque, Iowa.



Farwell Gear Tester.

*From information supplied by the Adams Co., Dubuque, Iowa.

Automatic Connectors for Brake and Heater Pipes on Railway Cars.

The use of mechanical devices for automatically coupling the air-brake and steam-heating pipes of railway cars (as the cars are brought together in making up trains) has been proposed many times. Numerous devices for this purpose have been invented and tried experimentally, but their use in practical service is as yet very limited. In 1908, a committee of the Master Car Builders' Association reported upon these devices and made recommendations in effect as follows: (1) the connector or coupler to be of the butt or end-port type, rather than the lapping or side-port type; (2) the collecting and registering devices (to bring the couplers into engagement) to be of the pin-and-funnel type rather than the wing-and-tongue type; (3) the center line of the air-brake port to be 17½ ins. below the center of the car coupler; (4) the ports to be arranged in a vertical line, with the air-signal port at the top, then the air-brake port, and then the steam-pipe port; (5) in view of the development of electric traction on steam railways provision should be made for a fourth port (above the air-signal port) for electric connections.

In a paper read before the Western Railway Club (Chicago) and published in the September number of its Proceedings, this subject has been discussed at some length by Mr. W. C. Squire, of Chicago. A number of devices are described and illustrated, but nothing is said as to the number in use. From this paper we extract the information given herewith. It is stated that automatic connectors have been designed and experimented with for at least 30 years.

The earliest designs were generally of the butt-face type, although the side-port or lapping type (in which two faces carrying gaskets slide by each other) was almost as early. Of the collecting or collecting devices (to bring the connectors together) the pin-and-funnel type was the earliest; it has been selected and abandoned more than any other design. It is considered that there must be some inherent defect in the design, or it would not have been abandoned so often; but that on the other hand it possesses features that commend it to everyone who first approaches the subject. One objection is the length of pin required to ensure a wide range for engaging, and the author suggested a cone-and-funnel type as a desirable modification of the older forms.

The connectors should have a range of at least 4 to 6 ins. vertically and 8 to 9 ins. laterally on either side of the normal center line. They must be atuomatically locked together when once the faces have registered, so as to hold the gasket faces in tight contact while the connectors swing freely in allowing for the vertical and lateral displacement of the cars. This lock must be strong enough to stand the 110-lb. air pressure of the high-speed brake apparatus, 60 to 70 lbs. pressure for the air signal, and as high as 150 lbs. for the steam heating system. While it is not intended that there should be such steam pressure, an excessive pressure is sometimes carried. This device would lock and unlock simultaneously with the making and breaking of the connection. A desirable feature of the connector is a simple means of renewing the gaskets without having to uncouple the cars. This is included in some designs.

In regard to the adoption of a standard or interchangeable design, it is suggested that any designer or inventor whose device is recommended by the Master Car Builders' Association should be willing to waive his rights and give to the railways the contour lines of his connector. No design would be adopted as standard unless these rights were waived, but "the prestige of this action would be of great value to the party whose design is adopted as standard." The purpose of this action, of course, is to avoid giving to the inventor of the design adopted as standard an entire monopoly of the business.

As the connector is an important part of the air-brake system, it should be approved both by the Master Car Builders' Association and the Air Brake Association. It must permit of ready connection to the present standard hose attachments, so that it will not cause trouble during the transition period of the change from hand to automatic coupling. Mr. Squire favors rubber hose rather than metal pipe connections for the couplers. He suggests that makers of these pipe couplers will simplify their introduction if they provide for using the present standard air, steam and signal hose connections generally.

Automatic connectors on freight cars operate under more severe conditions than those on passenger cars, owing to the less frequent inspection and the rough usage, at least until brake inspectors and others have learned how to look after these devices. It has been found that the proportion of connectors defective or unavailable on freight cars is much greater than that of connectors on passenger cars. The same form of connector should be used for both passenger and freight service. The opinion is expressed by Mr. Squire that there are now on the market connectors suitable for regular service, but that they must be proved by a period of actual service. If the railways delay the use of the connectors because they are not yet perfect, they simply delay the perfecting of the devices. With connectors in regular service, their improvement and development would proceed rapidly.

Gas Power Development: A Review.*

By J. R. BIBBINS,† M. Am. Soc. M. E.

At the opening of the present century, many were the prophecies of epochal development in all branches of the technical arts. I believe the decade has fulfilled its promise. First by way of comparison, we find the steam turbine grown from 300 to 30,000 HP., with practice both in Europe and America gravitating toward a combination of the two principal types. We find single boiler units increased from 300 to 3,000 HP.; we find the steam engine, then fully developed, now endowed with a new lease of life through association with its erstwhile rival; we find the electric generator literally decimated in bulk but still larger than its turbine.

But returning to the field of gas power; here, too, is measurable progress. In size, engines have developed from the single-acting units of 100 HP., or so, to the double-acting tandem units of 4,000 or 5,000 HP. designed for and operating under the same conditions as steam equipment including the parallel operation of alternating-current generators. We find the steel casting industry, then comparatively undeveloped, now able to turn out intricate one-piece gas-engine cylinders with jackets attached and crank disks with integral pins of the same material. We find producer units developed from a diminutive 10-50 HP. up to 1,000 HP. or more, and the problem of bituminous fuels well along toward solution, with practice tending in the direction of the induction type for both large and small units with self-contained vaporizer and continuous service. Opinion is somewhat divided as yet on the tar question, but all efforts are directed toward the abolition of this undesirable by-product by gasifying it.

INDUSTRIAL APPLICATIONS.—But in its varied applications, the direct combustion principle has indeed achieved success. It is obviously no exaggeration to say that the gas engine has made possible the submarine, the aeroplane, the motor boat and the automobile. The aeroplane motor offers an object lesson in the results of high rotative speeds. The 30-HP. motor of the Wright aeroplane weighs but 6⅔ lbs. per HP., while the Darracq motor of about the same size, built for the "Demoiselle" monoplane, weighs 3¼ lbs. per HP. The Gnome engine with radial rotating cylinders weighs still less.

Concerning the much discussed problem of conservation, I need only refer you to the utilization of blast-furnace gas, by-product coke-oven gas, by-product oil gas from refineries and various low-grade or by-product fuels unused for steaming purposes. A large power plant is now being built for using waste cupola gas, which in heat value, runs about 50 B. T. U. and requires 300-lb. compression. The importance of these developments in solving the smoke problem and the power problem of our specialized manufactories and in deferring the national crisis—the extinction of fuel supply—cannot be overestimated.

On the one hand, by reason of its high efficiency, the gas driven pump has found adoption in water-works, sewage disposal, hydraulic excavation and long-distance gas transmission. On the other hand, by reason of the absence of stand-by losses, it is equally desirable in emergency service such as fire protection, auxiliaries with hydro-electric plants and for canal lock operation. The coincident and related development of producers has brought about a revolution in such operations as hardening, tempering, melting, soldering, baking and cloth singeing and especially displacing the supposedly indispensable Bessemer converter with the open-hearth furnace in single units of 400 tons or over.

GAS ENGINE.—The development of the heavy-duty, double-acting gas engine has been accompanied by certain interesting features which, while not universal, yet find quite wide acceptance in American designs. Foreign center-crank designs have been generally departed from in the use of the side-crank, self-adjustable bearing construction. Experience has been gained with various cylinder materials, all steel or all iron, steel walls only, cast-iron liners, both iron and steel pistons and with steel on steel. The trouble predicted with the latter does not seem to have materialized. Krupp builds thin walls with longitudinal reinforcing tension rods while other foreign builders design cast-iron walls as thick as 3 ins. Dry metallic packing has been substituted for the elaborately water-cooled style. Fads in valve gear have disappeared and the mechanism has been simplified by driving both inlet and exhaust valves from a single cam.

In early practice the regulator was quite generally driven from any convenient point along the cam shaft, but now directly from, or at a point close to, the main shaft so as to avoid cyclic torsional effects in the cam shaft. Direct governing has largely been replaced by the relay type using drop cut-off or positive oil pressure to actually move the valves. This has permitted the use of a very small regulator, usually on the German straight line principle, as represented by the Jahns & Hartung design, the weights moving directly against spring pressure. Mixing is now done only at the inlet valves, thus minimizing the result of a back fire. By the symmetrical distribution of gas and air with reference to the four inlets, non-uniform mixing due to unequal fluid-inertia effects has largely been overcome. The electro-magnetic igniter has found much favor by reason of its simplicity, and has made possible ignition at several points in the combustion chamber which has brought more rapid as well as surer combustion with lean gases. A series system of circulation has reduced the water consumption and also the troubles from sweating of cold rods with high sulphur gas. The foreign practice of cambering rods is entirely disregarded here, for with light, one-piece pistons, the rod flexure is not greater than considered desirable to keep the sectional packing free. And finally, centralized, continuous return, lubricating systems are the rule for engine oil, with timed force-feed for cylinder oil. This latter replaces all attempts at graphite lubrication or indiscriminate injection of oil during combustion.

The special adaptation to direct connection to reciprocating compressors has brought about the variable speed, long stroke gas engine (of two diameters or more). These are operated in the natural gas districts of the Central and Western States. One company alone has 24 of these units in service, of about 1,300 HP. each. An interesting feature, brought out by some recent tests by the author, is that for the same power output the gas and heat consumption is not widely different at full or reduced speeds.

A moderate size double-acting engine has also come into use with about 2-ft. stroke whose high rotative speed (200 r. p. m.) is of great advantage in direct-connected electric drive.

The gas-electric motor car is another interesting development which has been under investigation for several years by railroads for service on extensions or suburban branches where regular steam equipment would not be justified. These cars are self-propelled by a compact eight-cylinder, high-speed generating set located in the cab and standard electric-motor control. Sixty-seat coaches ordinarily make an average schedule speed of 25 mi. per hr. including stops. Demonstration runs have resulted in a gasoline consumption of .36 to .48 gal. per car-mile. A single-truck car of this type has been on trial for cross-town service on some of the lines in New York City that have not yet been electrified.

So much for progress and accomplishment. The evidence exists throughout the land from the barking thousands of small engines upon the hillsides of the Pennsylvania oil fields to the great installations at Gary, Buffalo and Pittsburg—in the Mexican highlands a central station burning mesquit, in Texas using lignite, in Canada peat—in the Nevada Ranges a mining plant with Diesel oil engines—in Nova Scotia and Buenos Ayres other engines running railroad shops—in Ohio boosting gas to Cleveland—in Arizona watering the Imperial Valley reclamation—in Philadelphia and Coney Island providing high-pressure fire protection—in Pittsburg operating the locks of the Ohio Canalization project. This is admittedly a good record but we should never be guilty of that smug satisfaction that blinds us to minor shortcomings, so let us glance at some aspects and causes of retarded development.

Retardation.

A very serious handicap in industrial work is the present inability of the gas-power system to supply means for factory heating in lieu of exhaust steam. This is particularly serious in the northern states and in Canada. Unfortunately the high efficiency of the gas engine is lost when a "steam eater" is desired in connection with a heating plant. Some progress is being made with the manufacture of exhaust heaters but the available 5,000 or 6,000 B. T. U. per B. HP. is not sufficient for heating a large factory. Some system of auxiliary gas-burning heater must be worked out with automatic temperature control to compensate for variations in load. An attempt should be made at conserving this 60 odd per cent. waste heat, now rejected in the exhaust so as to return the major part of it to the heat cycle.

The gas engine is roundly scored for not having overload capacity for fluctuating peak loads. Now with an efficient regenerating heater operating in connection with a low-pressure steam-turbine auxiliary, it is possible to largely increase the output, or vice versa, decrease the fuel consumption. I am glad to report that one of our manufacturers is working along this line on a projected plant.

We must have more convenient and practical methods of measuring power gas both with respect to volume and heating value. No sensible individual would attempt to operate a steam plant without a pressure gage, even neglecting the personal risk, but with gas we are working continuously in the dark and with engines equally as sensitive as steam engines to reduced "potential." Some large plants have, of course, adopted the Venturi meter, but even this simple apparatus is sensitive to deposits in the throat. A continuous recording calorimeter is a great necessity and some progress is being made in that direction.

There is a disposition to discount the demand for large units, both engines and producers. With turbine units increasing by leaps and bounds, the gas-power industry must respond in kind if not in equal measure or remain an "auxiliary" for "special conditions." The 44 × 60-in. cylinder is now in evidence. Let us have higher rotative and piston speeds with relatively shorter stroke and larger diameters if possible. It is to be expected that the production of special high-strength steels and further perfection of foundry practice will make this possible. This improvement in engine construction will remove one of the causes of complaint in the past on large engines—the failure of cylinders and pistons—due for the most part to shrinkage strains.

Nor can it be believed that the producer fuel bed has reached the limit of its diameter, nor the maximum rate of gasification. With a coal combustion of 15 lbs. per sq. ft. per hr an 8-ft. producer would yield only 750 B. HP. Marine and locomotive practice with induced draft succeeds with many times this rate. A full-grown power plant of to-day requires units of 3,000 to 5,000 KW. capacity with at least 2,000 HP. producers.

Finally, education not only of operator but of salesman and manufacturer is needed. The last named is often the least wide-a-wake, and the first the most receptive of intelligent guidance. The great mistake is made in semi-education—first an incomplete understanding of the conditions, second a make-fit equipment, third a jealous guarding of essential knowledge of defects. The result is loss of confidence, dissatisfaction, failure. When will we learn that to take the operator into our full confidence secures his allegiance for all times.

The Future.

MARINE PROPULSION.—This most important development looms big on the horizon. Much has been written of the producer-gas system, but it must be confessed that the oil-burning engine is more attractive from the standpoint of convenience and compactness. The advantage of storing oil in the ship's double bottoms is great from a standpoint of cargo capacity. European countries have been active in this development, Russia with its tank ships, France with its submarines and the coast countries with their fishing fleets. Successful producer-gas equipments are to be found on some of the inland waterways of Europe where coal is the cheaper fuel and a boat is now being equipped here for service in New York Harbor.

Recently has come the announcement of the adoption of oil engines for the 8,000-ton, 12.5-knot freight boats now being built by the Hamburg-American Line. These will be equipped with two 1,500-HP. Diesel engines built by the Augsburg & Nurnberg Works, and if the experiment is successful, similarly propelled passenger vessels will be constructed. One American builder, at least, has taken up the Diesel engine for marine work.

POWER FROM CRUDE OIL.—The oil engine development seems to have made great headway abroad since the expiration of the basic Diesel patents. Two of the principal companies have built together 250,000 HP. with four and six-cylinder units up to 1,000 HP. capacity per cylinder. Small Diesel engines have been built of from 5 to 30 HP. The smaller engines are mostly four-cycle, while above 1,000 HP. the two-stroke cycle prevails, which in an oil engine, works out much more simply than in a gas engine, where separate pumps are required for gas and air. Maximum compression is somewhat over 500 lbs., with air injection at 600 to 850 lbs. In most cases the compressors are built into the main unit and geared. Some of the builders are reported to be developing double-acting designs for engines of high power.

In London one of the electric supply companies has installed Diesel engines, using oil distillate to supplement the transforming equipment of its sub-stations, at a cost per kilowatt-hour lower than that for the main stations. A somewhat similar type of plant-operating in one of our eastern cities "boosts" the potential of low points in a direct-current distribution system. The generators, however, are under-compounded so as to limit the output and thus equalize with other parts of the network. Obviously, the oil engine is an ideal prime mover for such service.

In the various experiments with oil-gas producers, the small progress has been discouraging. Two systems have been used, the retort and the partial combustion. In the former, difficulties with carbon deposition in the retorts are encountered; in the latter, excessive production of lamp black. Both are hopelessly low in efficiency as compared with the oil-burning steam plants. A large oil-gas plant in California, operating gas engines as water-power auxiliaries, endeavors to apply to power purposes mixed gas, consisting of part retort and part carburetted water gas, utilizing the carbon deposits of the former as briquettes in the latter process. In this mixed gas, the hydrogen content is kept down to about 30%, but in the oil-gas it is very much higher, 40 to 60%. For straight power purposes the combustion producer seems more promising both in simplicity and efficiency. The Imperial Valley project is being served by a small lift station of this type at Yuma, Arizona.

POWER IN THE WEST.—Closely related, is the development of the Western power fields, both for irrigation and for mining operations. The Easterner cannot

*Chairman's address before Gas Power Section, American Society of Mechanical Engineers, New York City, December, 1910.

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realize to what extent irrigation has taken hold of the West and what a field there is for power pumping if it can only be developed. Utah, Arizona, Texas and the Great Plains embrace broad areas underlain by basins or hardpan yielding ground waters at a depth varying from a few feet in favored areas to 50 to 75 ft. in others. At present electric power pumping is predominant. John C. Hays* in discussing a California installation, mentions an area of 1,050 square miles, 86% of which is electrically irrigated. He declares, "there is no reason why this field should not be open to gas-power pumping." One installation is already projected with gas-driven generators, but why not direct pumping? No one familiar with the ever-present gas pumpers of the oil fields will fail to see the parallel. But we must have a low-priced engine, simple, fool proof, and preferably of high speed, multi-cylinder type, adapted to direct connection to centrifugal pumps. Present types of high-speed engines are not really adaptable to rotary pumps because of the disparity between impeller proportions and engine speed, although a few sizes can be found suited to low head work. The new Humphrey gas pump is evidently well suited to this service; in fact, some of these pumps are now operating in irrigation enterprises in India. Recently a unit as large as 25,000,000 gals. has been contracted for. This pump utilizes the water column itself as a piston and is approximately "fool proof."

A crude oil engine is obviously a necessity in the Far West. East of the Rockies, lignite suction producers in small sizes would find application; but in California, oil predominates. In 1908, the oil production in California was 48,300,000 bbls. at an average price of $0.54 per bbl. The majority of this was asphaltum base oil, 12° to 17° Baume.

In the mining districts, we find wood, charcoal and black lignite used for steaming purposes even where water is scarce and impure. One plant, however, accepted the situation and installed Diesel engines with a continuous, closed, fan-cooling system for jacket water.

The development of lignite deposits in the middle west is encouraging. In 1907, the output west of the Mississippi was 5,000,000 tons, of which Colorado produced one-third, with Wyoming and Texas next in rank, with an average price of $1.55 per ton as compared with $1.12 for all bituminous coal mined in this country. This price does not of course apply to the more inaccessible regions, where fuel costs $4 to $8 per ton. Here in the West is an opportunity.

CANADA.—We have looked to Canada for important developments in the use of peat, but private experiments have failed so signally that the Government has started a peat manufacturing and power plant to demonstrate the process on a commercial scale and re-establish confidence in this industry. Director Haanel of the Canadian Bureau of Mines thus summarizes his investigations, "Artificial drying processes have failed commercially and a machine process must be substituted for the manual labor." The Department is therefore proceeding along European lines of established success. He states that Russia alone produced 4,000,000 tons of peat fuel in one year, 1900. Peat containing not over 25 to 30% water has been found an ideal fuel for gas producer work. It requires no further vapor and is quite free from high temperature and clinker. The long series of fuel tests at Montreal have served to confirm the results of our own Government's tests on lignites in demonstrating the great possibilities of these lignite deposits, especially in the Canadian Northwest.

SELF-STARTING ENGINE.—No real progress is apparent in the self-starting gas engine. Some automobiles are equipped with small compressed air motors, but at considerable expense. No simple combustion method has yet appeared. The opportunity is clear. On very large units, one builder employs for starting an explosive mixture compressed to about 80 lbs. and stored in the same manner as the usual compressed air. Some trouble has been experienced in guarding against back-fires into the storage tank.

DOUBLE-DECK STATIONS.—In large cities where land is dear, a new style of power plant would seem to have some possibilities, viz., the double-deck type with the producer plant above. This has some advantages over the familiar double-deck turbine plant in that the steel work of the building would be designed for a dead load, concentrated along the supporting walls where the producers would naturally be located. I am not sure of the comparative costs, but the economy in space in a large plant works out relatively low.

ENGINEERING ECONOMICS.—Returning now to a consideration of some of the broader aspects of this subject, it seems to me that there are some fruitful fields still undeveloped. Engineering to-day has become not entirely a technical, but an economic science as well. We must not only ask the question, "Will it work?" but first and foremost, "Will it pay the proper return on the investment?" Consider for example the total cost of power production. How much earnest effort has been thrown away in fruitless discussions of mere operating costs, technical finesse, when the language of fixed charges, depreciation, obsolescence, supercession and business risk had not fully been learned. This phase of gas power development has been of serious consequence in the past and undoubtedly responsible for many of the failures on record. Such problems continually arise in the course of comparative studies of gas producer and turbine plants with various load factors and prices of coal. The success of the by-product, coke-oven industry in realizing profits from its by-products, rests solely upon the economics of the case, and abruptly raises the question, "Which is the major product, gas or coke?" The analysis of the cost of production is of far more importance than that of microscopical improvement in efficiency.

*American Institute Electrical Engineers, May, 1910. The Mt. Whitney Power Co.

TECHNICAL CONSULAR ATTACHE.—No one can deny the great value of detailed knowledge of the development of the arts in foreign countries. Private individuals or corporations constantly invest large sums in securing such information for their purposes. Now in view of the extended activity of our government along scientific and commercial lines as evidenced by the Geological Survey, the Bureau of Mines, the Bureau of Standards and the Smithsonian Institution, does it seem unreasonable to broaden the usefulness of our consular service by the establishment of a new function, a technical investigating staff whose duties would be to keep constantly before American engineers the more important achievements of foreign contemporaries? The excellent report on "Peat and Lignite" by the Canadian Bureau of Mines is a case in point. The fact is that progress to-day is so rapid that no individual can hope, unaided, to keep abreast without expending time in general investigation that should properly be detailed to special talent. And it seems to me that the national engineering societies should be the leaders in fostering this activity.

COOPERATIVE RESEARCH.—The movement toward the cooperation of the engineering fraternities with the educational institutions should be encouraged, first by the more widespread establishment of technical apprenticeships in our shops and offices. It is no exaggeration to assert that to-day the technical graduate furnishes the new blood of industrial enterprise. His training and his ideals form the groundwork of a steadily improving standard in commercial life. By the same token, the colleges have a right to expect cooperation. Their costly laboratories are at our disposal for the asking. We spend millions in commercial experiments that can at least only yield approximations. Many of these investigations should be transferred to the laboratory.

There is now before the technical institutions of the country a comprehensive list of subjects needing scientific investigation, many of them of the utmost importance. Could we persuade the manufacturers of the country to endow graduate fellowships in their chosen fields with ample funds for defraying the material costs of such investigations, the return on their investment, I believe, would be well above the "market rate" of interest. A few progressive concerns have taken this step, but they may only be regarded as a precedent. One technical institution has itself provided an endowment.

Interest the student in your business by affording him some incentive and he will become a loyal apprentice, an effective salesman and a competent executive. I beg to suggest that this section take more definite action through the society, along these cooperative lines. As subjects, I need only mention the following as typical. Are there any manufacturers interested?

(a) Maximum efficient rate of combustion in producers as affected by width and depth of fuel bed, rate of blast, moisture content and character of fuel.

(b) Study of chemical reaction in the fuel bed to determine the conditions for suppressing the formation of tar or lamp black and securing maximum percentage of combustibles in gas, together with high overall efficiency.

(c) Study of the relative jacket absorption with varying time contact due to different combustion-chamber and cylinder proportions, and piston speeds.

(d) Effect of auxiliary precompression of charge on efficiency and power of gas engines with reference to securing unlimited overload capacity.

(e) Determination of the most suitable form of gas-engine indicators to standardize accurate methods of working.

(f) Research work on maximum heat values of combustible mixtures, standardizing formulas for the standard reference cycle.

It seems to me that the progressive spirit of the true investigator is well expressed in a little quatrain of Rudyard Kipling, entitled "Initiative and Leadership." It runs thus:

They ask him how he did it and he gave 'em the Scripture Text,
You keep your light a shining a little in front of the next.
They copied all they could follow but they couldn't copy his mind,
And he left them sweating and stealing a year and a half behind.

The answer is, initiative pays. Anybody can follow.

WORK OF THE SECTION.—Finally as to the work of the Gas Power Section. The interest manifested in the last few meetings indicates that it has been productive of results. Out of 180 papers presented to the Society within the last five years, 24 have been devoted to gas power or related subjects, two committees have presented comprehensive reports, and a third committee on detail work from time to time. Although none of the committees now at work have reported conclusively, their preliminary reports have furnished ample basis for further action. Possibly the most pressing need is that standardization of tests and efficiency determinations. These matters were brought to the attention of the Society in concrete form by the standardization committee of this Section and are now in the hands of the power test committee of the Society.

The greatest value, therefore, of the section rests in the contributions to the art in the papers or reports presented. We should not glory in mere numbers, but, on the other hand, excessive concentration in the choice of subjects does not effectively reach the full membership. We may well accept the two contributions on blast-furnace practice as an earnest of our desire for contributions of the highest possible standard. I have heard Lord Bacon quoted on this theme, "I hold every man a debtor to his profession, from the which, as men of course do seek countenance and profit, so ought they of duty endeavor to be a help and ornament thereto." This seems sound doctrine, and in the belief that it will not fall on arid ground, I look for the continued growth of this membership with the very keenest interest.

A Deflection Recorder for Track Switches.

A track switch in proper condition will have one point rail held tightly against the main or stock rail in either position of the switch. Under the severe usage from traffic the various parts and attachments are liable to wear or become slack, and this slackness tends to increase rapidly under the shocks and vibrations due to passing trains. If under such conditions (or from any other reason) the switch rail shifts from its position it may lead to accident through wheel flanges striking this rail or passing between it and the main rail. One of the important details of track maintenance, therefore, is that of keeping the switches in adjustment and repair. But if this work should be overlooked or neglected the defective condition of the switch might ordinarily remain unnoticed.

It is true that switch locks are used as a rule in connection with interlocking apparatus, and sometimes on individual switches, but there are thousands of switches in which reliance is placed simply upon the maintenance of the parts in proper condition. As a check upon the maintenance work and a means of detecting faulty conditions, a device has been invented for detecting and recording any movement of the switch rail relative to the main rail during the passage of trains.

The construction of this recording device is shown in Fig. 1, while Fig. 2 shows it applied to a switch point. It consists essentially of two brass bars which are clamped to the main and switch rails respectively. The bar (A) is bolted to the inner side of the switch rail at one of the switch-rod connections, and its tail end passes under the rails to the outside of the track. To the outside of the main rail is bolted the bar (B) having a stem (C) through which passes the tail of rod (A). The screw (D) provides for leveling the bars and bringing them to an approximately horizontal position. On the lower bar are two rectangular clamps (E) with set screws, by which a strip of paper (F) is clamped upon this bar. This strip is directly beneath the pencil holder (G), which is clamped to the upper bar. The pencil (H) is fitted to a barrel (J) sliding in the cylinder (G) and above it is a spiral spring. The set-screw (K) provides for holding the barrel in place in the cylinder when the apparatus is not in use. On the back of the cylinder (G) is a hollow lug (L) which is slipped over the arm (B) and clamped in position by the set-screw (M).

The device is readily attached to the rails, and is then left in position during the passage of a train (or trains). Any lateral movement of the switch rail in relation to the main rail will then be recorded as a short line on the paper slip, a separate slip being inserted for each train. If the heel of the switch is low, allowing the point rail to pound up and down continually under the movement of trains, the pencil or marker will punch a hole in the paper. An examination of the record slip shows at once what adjustment (if any) is necessary and indicates whether the maintenance work has been slighted.

When deflection records are taken, it is the practice to take records also of the throw of the switch, to see that this is of proper amount. For this purpose two or more devices may be attached, one at each switch rod. By a slight modification of the attachments the device can be used also to record lateral movements of rails upon the ties or tie-plates. This is a matter of importance in regard to the design of tie-plates and the efficiency of rail fastenings.

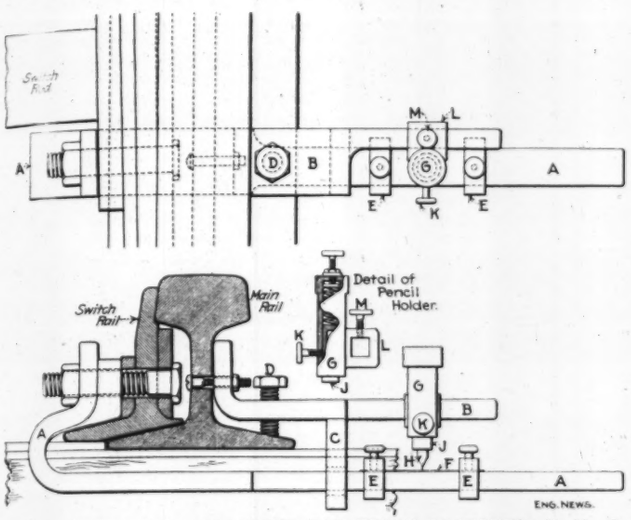


FIG. 1. DEFLECTION-RECORDER FOR TRACK SWITCHES: N. Y., O. & W. RY.
C. E. Knickerbocker and W. H. Harland, Inventors.

The device above described has been invented and patented jointly by C. E. Knickerbocker, Engineer of Maintenance-of-Way, and W. H. Harland, Signal Engineer, of the New York, Ontario & Western Ry.

An important feature of its use is its moral effect upon the section foremen. Knowing that such records may be taken at any time by a superior officer, they are specially careful to keep their switches in good condition, so as to show a favorable record. In fact, one of the advantages claimed for this device is that it encourages good maintenance, which is not only an element of safety but also tends to an increase in the life of the switch points and the switch generally. All records are filed permanently in the office, and may be important in case of accident. Thus, if it is claimed that a derailment was caused by the defective condition of a switch it may be possible to show recent records of good condition of this particular switch.

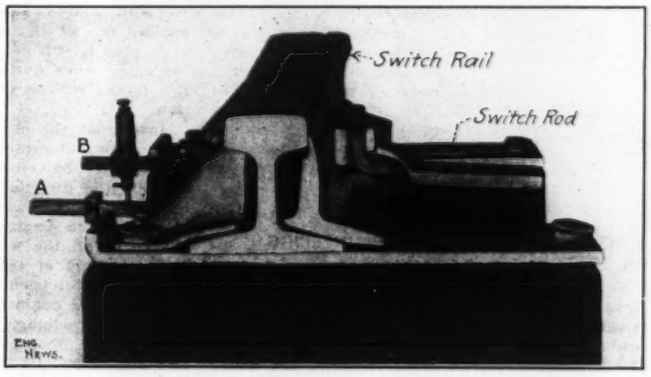


FIG. 2. DEFLECTION-RECORDER ATTACHED TO A SWITCH.

THE NATIONAL FIRE PROTECTION ASSOCIATION has been requested by the National Board of Fire Underwriters to take over the work of the Underwriters' National Electric Association and the Committee of Consulting Engineers of the National Board. These two latter bodies were heretofore unaffiliated. The National Fire Protection Association has furnished standards for all protective devices and systems, the Committee of Consulting Engineers has handled the hazards of gases and oils, and the Underwriters' National Electric Association has been responsible for the National Electrical Code.

The Underwriters' National Electric Association will become the Electrical Committee, and the Consulting Engineers will become the Committee on Explosives and Combustibles of the National Fire Protection Association. The personnel of these two committees will be the same as that of the two former separate bodies, with the addition of one or two members to each.

Boston's New Department of Public Works Under One Engineering Head.

By BENJAMIN BAKER.*

The reorganization of the Boston City Engineering departments, by which the work of the water and street departments and that of the City Engineer are combined under the authority of a single engineer head, with the title, Commissioner of Public Works, is a matter of more than usual interest. The ordinance authorizing the change was passed by the City Council on Nov. 14, and was signed by Mayor Fitzgerald on Nov. 29. Its provisions will go into effect on Feb. 1, 1911.

From the merely civic or municipal efficiency point of view, the new plan is of interest because it promises to put an end to that conflict between departments working in the same area which has been responsible for much of the waste of money and for unsatisfactory results in the past. From the point of view of engineers as professional men, the plan has a strong appeal in that it claims for the municipal engineer the executive control and responsibility for the carrying out of his own designs which at present he does not generally have. From a third point of view the new plan, and the experience in the Panama Canal Zone upon which it is based, offer some contributions of value to a discussion of general methods of organization.

Mr. Louis K. Rourke, M. Am. Soc. C. E., the present Commissioner of Streets in Boston, who was for four years Assistant and Acting Division Engineer on the Panama Canal, devised the new Boston plan. It is similar in principle to the scheme of organization that Mr. Rourke instituted on the Culebra Division of the Canal work, and which Colonel Goethals later extended to the whole zone.

When Mr. Rourke left the canal work and went to Boston to become Commissioner of the Street Department he found in the Boston engineering departments the same functional scheme that he had displaced at Panama, complicated by the addition of the endless pulling and hauling due to politics. At present (see accompanying diagram) the Mayor of Boston appoints a Water Commissioner, a Superintendent of Streets, and a City Engineer, these three being entirely independent of each other. The City Engineer's office was concerned with designs for new construction, but had no responsibility whatever for maintenance. The Water Commissioner and the Superintendent of Streets might ask the City Engineer's advice or not, as they felt disposed. Between these two latter department heads there was endless friction and interference with each other in their conduct of the city's business. The Water Commissioner's men might open a street, lay a water main, and close the street again, just after the Superintendent of Streets had laid down a new pavement. The Water Commissioner was under no obligation when he opened a street to replace the surface in a way that should satisfy the Superintendent of Streets.

The situation was made a great deal worse by the fact that in Boston all three of these offices were regarded as political places. The late city Engineer, Mr. Jackson, was reappointed by different mayors for many years in succession, and his office was in fact not a political office, though this situation was due entirely to Mr. Jackson himself and not to the plan of organization. The positions of Water Commissioners and Superintendent of Streets were well recognized political plums, and they were bestowed generally where they would most benefit the dominant faction in city politics. The natural result, of course, was to make these two departments of water and streets great political divisions in which engineering and construction work were more or less subordinated to political ends.

Mr. Rourke's first aim in planning a new system was to concentrate responsibility. His second aim was to put engineers in charge of engineering work, and to make the engineers who were responsible for the planning of work, responsible also for its construction and maintenance under the plans they had made.

The first step was to put the three engineering branches of the City Government under a single engineer head. The second step was to make the heads of the divisions under this single head, engineers of recognized standing, who should be protected in these positions as far as possible by civil service rules. This reduced the political places in the gift of the Mayor from three to one. The diagrams show the main outlines of the present and of the new system of organization.

Mr. Rourke in classifying the different engineering functions, has followed in part the practice which prevails in German cities. In Germany all municipal work is separated into the over-surface and under-surface divisions; and both engineering and executive control within these divisions is given to the engineer in charge.

In accordance with this principle the new division engineer in charge of the sewer and water divisions will have entire control of the design, construction and maintenance of sewers, water mains, service pipes and all other sub-surface construction, with certain slight exceptions that would at times arise in connection with the bridge department's construction work. The division engineer in charge of the highway division will have entire control of paving street cleaning and sprinkling, the collection of garbage and refuse, and street lighting. Bridges, and ferries (which Mr. Rourke treats as floating bridges) will be in charge of the division engineer of the bridges and ferries division.

The ordinance creating the new Department of Public Works naturally goes into minute detail regarding the powers and duties of the Commissioner, but most of these specifications are of merely local interest. A few points, however, deserve mention.

The completeness of the authority of the Commissioner over construction work for the city, is shown by Section 32 of the ordinance, which says:

> Said Commissioner shall have authority to order any public work, whether done by a department, or under contract, or otherwise, to be discontinued, reconstructed or removed, whenever in his opinion said work fails in any manner to comply with or fulfill the terms, conditions, specifications and requirements of any such contract or agreement, or fails in his opinion to conform with proper engineering standards.

In regard to the qualifications of the Commissioner, any appointment by the Mayor to that position* must be approved by the Civil Service

*170 Summer St., Boston Mass.

[*Or any other appointment by the mayor to any position.—Ed.]

Commission before the appointment becomes operative. There seems to be no provision in the present Charter of Boston making appointments as Division Engineers under the Commissioner subject to the specific approval of the Civil Service Commission, although these positions must be filled from the Civil Service lists. In default of that, the ordinance requires (Sections 35 and 36) that:

> Each division of the department created or changed by said commissioner with the exception of the water income division shall be in charge of a civil engineer of recognized standing in his profession and an expert in the duties which may devolve upon him, such division engineer to be appointed without regard to party affiliations or residence at the time of appointment, each head of a division to devote his whole time to the work and to receive an annual salary of not more than $5,000 with no other fees or emoluments.
>
> In appointing an engineer to take charge of a division of the department the commissioner shall certify that he is a civil engineer of recognized standing in the profession, that in the commissioners' opinion he is an expert in the work which would devolve upon him, that he is a person specially fitted by education, training or experience to perform the duties which may devolve upon him, and that the appointment is made solely in the interest of the city—this certificate to be filed with the city clerk and open to public inspection.

The creating of divisions of the new department is left in the discretion of the Commissioner, and the diagram showing the new plan of distribution, therefore, represents merely the initial stage of the organization. It may later appear that some further subdivision is desirable to meet needs that are disclosed, and in that event the Commissioner has power to change the scheme as he sees fit.

While no appointments have been made as yet under the new scheme, it is of course considered as settled that Mr. Rourke will be the Commissioner of Public Works, with a salary of $9,000. For the three division engineers under him Mr. Rourke has selected Messrs. Frank A. McInness, now Assistant City Engineer, as Division Engineer in charge of the Sewer and Water Division; James H. Sullivan, now Deputy Superintendent of Highways, for Division Engineer in charge of the new Highway Division; and Frederick H. Fay, now of the Engineering Department, for the Bridges and Ferries Division. All three men are civil engineers, and Mr. Rourke says that when he submitted their names to the Civil Service Commission he found they stood at the head of the engineering list. It seems to testify to the practical wisdom of Mr. Rourke that he should have been able to find suitable division engineers in the present list of the City Department, avoiding by this any possible creation of friction by "importing" his division engineers from the outside.

Certain criticisms of Mr. Rourke's plan serve to bring out some of its characteristics which its friends consider of special value. There is no reason to fear, for instance, that a competent commissioner of public works will be overwhelmed with administrative detail or with the task of being his own chief engineer. On the engineering side it should be remembered that the engineering problems of a city are not likely to be at any one instant technically difficult, very detailed and requiring immediate decision. Furthermore, one of the objects of having engineers in charge of each of the divisions below the commissioner is that all engineering questions shall come to the commissioner only after they have been reduced to their lowest terms by the engineering staff of the division engineer in whose province they originate. Under any reasonably efficient administration of the separate divisions, the matters requiring any great thought or time from the commissioner should be rather few and far between, and the commissioner should be of such engineering skill that when problems are prepared for his decision or approval he can discover quickly whether or not the plan is right, or in what general way it needs to be changed.

On the side of administrative detail the case is much the same. It is recognized well enough that not all engineers are good executives; but it is true also that many engineers do have executive ability, and are quite competent to direct the administration of a department in addition to directing the technical work of their own engineering staffs. It is, of course, obvious that if the commissioner under the new plan should appoint as his division engineers, men without executive capacity, the commissioner himself would soon be overwhelmed with a burden of details which should have been disposed of by his subordinates. But this possibility, of course, exists with any scheme of organization.

From the point of view of the engineering profession, the new plan makes a somewhat new claim for the engineer as an executive officer. In American cities generally, the ultimate determining of construction work is supposed to rest more or less completely in the determination of an engineer, but in actual practice the political appointee usually intervenes in such a way as to make the engineer's position mainly advisory.

Both because the details of it have never been published, and because it bears very directly on the Boston reorganization, the administrative system which Mr. Rourke introduced into the engineering and construction work on the Panama Canal is worth a few words of brief description here.

In 1906 Mr. Rourke was Superintendent of Tracks in the Culebra Division of the Canal Zone. Previously, during 1897-99, he had been engaged on the Panama Railroad under the New French Canal Co. During the absence of the Division Engineer in 1907 Mr. Rourke was appointed acting Division Engineer. He had under his direction at that time in the Culebra Division five Superintendents, namely, the Superintendents of Tracks, Dumping, Steam Shovel Work, Mining, Transportation, and a Resident Engineer, who was mainly an adviser to these Superintendents. These six men were entirely independent of each other, reporting only to the Division Engineer. The working of this form of organization was decidedly bad. A difficulty that arose again and again was this: The Steam Shovel Superintendent might fall behind on his excavation. When asked for an explanation he might give as an excuse the fact that the Transportation Superintendent had not provided him with cars. The Superintendent of Transportation might then allege that he could not provide cars enough because the tracks were obstructed. The Superintendent of Tracks might explain that the Superintendent of Mining had obstructed the tracks with masses of rock and debris from blasts; and as for the Superintendent of Mining, everybody knows that dynamite occasionally will act erractically even under the wisest management.

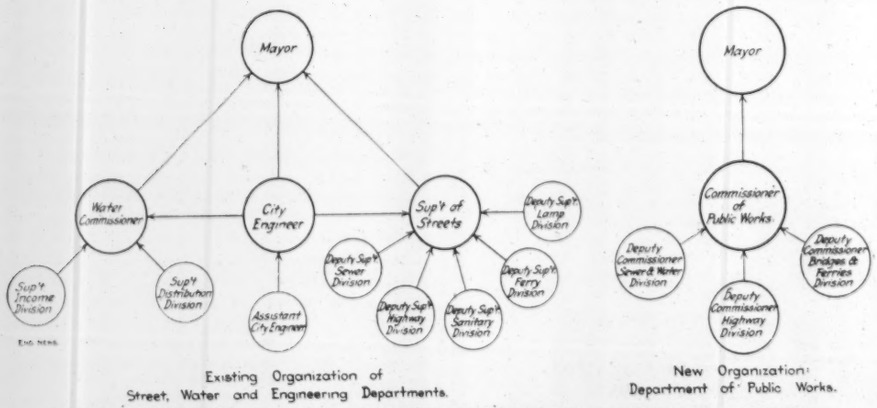
This form of organization was not giving satisfactory results, and while Mr. Rourke was Acting Engineer of the Culebra Division, Colonel Goethals asked him if he could devise any better system. Mr. Rourke thought he could, and with the sanction of Colonel Goethals he set about the job in this way:

First he divided his Culebra Division into three zones. He appointed a Superintendent of Construction for each zone, making him responsible for everything except train crews and rolling stock within his own territory. He then appointed two more Superintendents to take charge of the dumping and wasting, one at each end of the Culebra Division and outside of the boundaries of the Division itself. The sixth superintendent was the Superintendent of Transportation who, as already noted, furnished train crews, engines and cars for the work of the whole division. The existence of this Transportation Superintendent was a departure from rigid theory which was made necessary by the fact that the demand for cars fluctuated from day to day on different sections of the division, and economy required the fullest use of the rolling stock actually on hand.

This plan absolutely fixed responsibility. If anything lagged or went wrong, there was a Construction Superintendent on the spot with full power to deal with the matter. As a result, the work on the Culebra Division became much more efficient, and in 1908 Colonel Goethals reorganized the whole canal work on the same plan. That plan is still in operation, and the results of the canal work during the last three years certify to the efficiency of the scheme of organization.

How great the change was will be more evident from an outline of the functional system which prevailed before this plan was adopted. Up to 1907 the direction of the canal construction and engineering work was distributed among eight division engineers, several of whom had charge of all the work of a specified character from one end of the Canal Zone to the other. These eight divisions were (1) locks and dams, (2) municipal engineering, (3) dredging, Atlantic side, (4) dredging, Pacific side, (5) Culebra Division, (6) Chagres Division, (7) Motive power and machinery, (8) building construction. Under the present plan the zone was divided into three divisions, namely, (1) the Atlantic Division, from deep water in the Atlantic southward including the Gatun dams and locks; (2) the Central Division, from the southern boundary of the first division southward to the Pedro Miguel locks and dams; (3) the Pacific Division, beginning on the north with the Pedro Miguel lock and dams, which it included and extending southward to deep water in the Pacific. This organization was put into effect in 1908.

From the experience at Panama it may perhaps be set down as a principle that when under functional organization the material conditions on which the work of any given department depends can be changed by the independent head of another functional department, then the whole functional scheme will pretty certainly prove unworkable. At Panama under the old system, while it was logical enough to make one engineer responsible for all locks, the plan proved defective because the tracks, trains, and dumps upon which the success of the lock work depended were under the control of men quite outside his authority.



DIAGRAMS SHOWING OLD AND NEW ORGANIZATIONS OF MUNICIPAL ENGINEERING DEPARTMENTS IN BOSTON.

[*Indentical, in effect, with the obligations placed on the mayor in appointing department heads.—Ed.]

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"Is it of practical usefulness to engineers?" That is the first question asked by the editors of Engineering News in examining articles offered for publication. There is an article published in the present issue of Engineering News which has nothing to do with engineering materials or tests and which describes no engineering work; yet it may very likely prove of greater usefulness to some young engineer than any other article which we have published this year.

A second question asked by the editors in examining contributions is whether the article in question will be interesting to the reader. This story to which we refer, describing the mistakes of an engineer, surpasses also in this respect.

The mistakes referred to were not errors in reading instruments or computing stresses or designing a machine. They were mistakes in dealing with men. And these are the commonest mistakes of all and the most serious in their effect upon one's life. It is far easier to find engineers who can deal with materials and computations, than it is to find engineers who unite with their technical qualifications the ability to deal with men.

There is, of course, nothing singular in this. The same thing is true of every other profession and occupation. Plenty of physicians and lawyers and clergymen and merchants succeed because of the personal qualities that win friends and patronage, where other men as well or better equipped will fail because of faults of temper and disposition.

But before we pursue this subject far we are minded to pause and ask what is meant by failure and by success. Our contributor writes of himself as an unsuccessful engineer. He means by that, evidently, that he has lost opportunities to attain and hold executive positions involving large responsibility and (perhaps) proportionate financial returns. Is that a satisfactory definition of success? Do those only succeed who attain such positions?

If that were true, then nearly all of us are failures in life. There are only a few places at the top. The great body of mankind must occupy humble positions.

Against such an idea of success, current though it be in the dominant thought of to-day, we venture a protest. Not but what it is a worthy ambition to occupy a position of large authority, and administer it ably. But there are other kinds of success besides the achievement of that ambition. As the years pass over our heads, some of us learn that other kinds of success give better and more lasting happiness. What are these other kinds of success? The author of the article in question gives a hint at one of them in his conclusion. He tells us that he has at this time, the confidence of his superiors, the respect of his subordinates, and the regard of his associates. It seems to us that a man who possesses such assets as these has won a success that many who occupy higher places and carry larger responsibilities might well envy.

And is it success after all, for which men are striving? Is not happiness really the end sought, and success, in winning place and fortune, only a means toward that end? Do not some of us in these days confuse the end with the means? Do we not at times, in our eagerness to grasp after success—or what people have come to regard as success—overlook too often the opportunities for happiness that lie all about us?

In the earlier days of Engineering News it was the custom to provide for the issue nearest the Christmas season some article which, while keeping well within the technical field this journal designs to cover, still possessed some of those qualities which the daily newspaper editor defines with the term "human interest." Of such a nature is the article on "The Fishery Harbors of Scotland," with which the present issue is started. The story of the development of this very important fishing industry in Scotland from its crude beginnings to its present enormous proportions is the story of the fight of a hardy people against heavy physical odds, a fight that deep-sea fishermen have always had the world over. Furthermore, there is revealed the economic condition peculiar to the fishing industry everywhere, the combination of a number of small, independent operators each working on his own account, but each dependent for his success upon a well-designed joint harbor. But it is in this matter of harbors that the English fisheries differ mostly from those of our northeastern coasts, and it is this that makes the description of their growth of interest to our readers, for all along the Scotch and English shores the engineer has been responsible for the very necessary harbor development.

The northeast coast of England and Scotland is one of the bleakest and most unprotected in the world. In a far northern latitude, removed from the warming currents that temper the climate on the opposite side of the island, with a broad, free sweep of polar sea down to the very shores, probably no more undesirable place could be picked out on the navigable waters of the globe wherein to locate harbors. As Mr. Taylor points out, the early efforts of the fishermen were directed solely to a utilization of the meager natural facilities for harbor construction, but as the trade grew, new and better landing places became imperative and the engineer was called in to construct harbors at locations convenient to the fishing grounds and the markets, regardless of the advantages provided there by nature. Thus developed a type of harbor construction which, though of only special application, has brought with a practice of harbor engineering for which the British are today justly famous.

It is because there is so little in the literature of engineering on the design of harbors on unprotected coasts that we have seen fit to publish this lengthy description of what are probably the finest examples of minor harbor construction in the world to-day.

Aside from the fundamentals of design, the description of these harbors takes on an interest on account of the early and frequent use of concrete in the marine structures. The behavior of cement concrete when subjected to the chemical action of sea-water and to the heavy battering which marine constructions on such an exposed coast must receive is an absorbing question for the engineer, and any test, either premeditated or observed in actual structure, is of most vital interest. It is, therefore, well to note that here in these stormy waters of northeast Scotland, cement concrete has been constantly used and when properly laid has proved quite satisfactory.

Some points on the use of concrete in sea-water may be noted from Mr. Taylor's article. First, any evidence of chemical attack on these concrete walls has been largely negative. The exposure of these breakwaters is so exceptionally severe—a glance at the 50-ft. waves shown in our engravings will convince one of that—that the chemical deterioration, which is admittedly slow, has no time to take place. One of the demonstrable facts in the study of the effect of sea-water on concrete is that physical abraison of the concrete surface is almost always necessary before the salts of the water can begin to work on the alumina in the cement. In these Scotch harbors, however, the surface has to be made strong enough to resist abrasion, because once started any physical deterioration is a matter of very rapid progress. The heavy impact of huge waves compress the air into whatever crevices may be formed and soon breaks open the mass long before any chemical action can take place. Thus any observed destruction has always been due to physical action and against that alone has any defensive effort been made.

Taking into consideration the severity of the service, the concrete has behaved admirably. For the very reason that it can be laid in mass without intervening weakening crevices or cracks into which the waves could enter, it is, when well laid, superior to rip-rap or mortar-jointed cut masonry.

Finally, the experience in the British harbor works confirms the best American practice in the matter of depositing concrete under water. It has been found that, with a fair degree of surface calm, concrete can be laid under sea-water in bottom-opening tremies with a resulting hard, dense structure, provided that care is taken to prevent the weakening planes of laitance at the end of a day's work and provided further that a slightly larger proportion of cement is used.

An exact knowledge of the stresses and deformation in the various members of a completed structure, as they act together in that structure, is knowledge which all designers would appreciate. Since that knowledge is impossible to acquire, on account of physical and economical barriers, the designer has always had to fall back on one of two methods of test: the laboratory test to destruction on individual members, or the deflection test on members in completed structures. The first of these tests is comparatively easy to make and has the advantage that the progressive behavior from initial load to breakage can be watched. Its disadvantage is, of course; that the separate beam, slab or column, if it be of concrete, manufactured and set up in a laboratory, may have a far different structure from the beam in a building. Furthermore, being an individual member, it cannot have precisely the same conditions of stress or loading as it would have in a building where it would be tied to other members. The second method avoids the last named difficulty of the laboratory test, but has the fault that only deflections can be measured, and deflections, especially in reinforced-concrete structures, are notably difficult to convert into stresses.

In concrete structures particularly has the need for a test of an actual complete structure been felt. It is with peculiar interest, therefore, that engineers will examine the report of tests conducted by the laboratory force of the University of Illinois on an erected reinforced-concrete building in Minneapolis. These tests were described by Mr. A. R. Lord in a paper at the Annual Convention of the National Association of Cement Users which is printed on another page of this issue.

Briefly, this test consists of the observation of the effect of increasing loadings on a floor panel of the flat-slab reinforced-concrete type, not only deflections of the slab being measured but

also the exact deformation of the concrete and of the steel which made up the slab construction. These observations were made with instruments which recorded the deformation closely enough so that, by the application of Hooke's law, the stresses could be determined in the steel within 3% of its elastic limit and in the concrete within 7% of its working stress.

To make the steel measurements, the concrete was stripped from a short length of certain rods, but not to a sufficient extent to affect the stress or deformation in those rods. Observations on the concrete were taken directly on the slab surface, thus guaranteeing accuracy of measurement for the extreme fiber at least. Loads were applied, up to 375 lbs. per sq. ft. over several panels, in small columns, of brick and sacked cement so that no arching action could occur, and the readings were taken on the central panel, so that the conditions were quite similar to those which the building would have under extreme loading. The maximum applied load caused a stress in the most heavily loaded steel so near to its elastic limit as to guarantee an observation throughout the range of elastic deformation.

We call attention to this test, not so much on account of the information on the stress conditions in flat-slab concrete floors, though such information is much needed by the profession, but because it opens up a new field of testing which we think is of the greatest importance to the concrete designer. One test, no matter how carefully made, is only an indication. Many other tests must be made before the behavior of flat slabs can be accurately determined, and this fact Mr. Lord himself makes note of in his paper; but the methods of conducting the test are clearly shown and the accordance of results prove that by tests of this sort, carefully made, a much more definite knowledge of concrete structures may be obtained.

Upon one feature of such tests Mr. Lord placed a deserved emphasis; that is, that they must be carried on by laboratory experts who appreciate the necessity for exact observation and for careful manipulation—an appreciation which the average field or construction man, or even designing engineer, does not possess. It is interesting to note that the Committee on Building Laws of the National Association of Cement Users announced at the convention that it would be glad to cooperate with any concrete building owner or constructor to the extent of providing instruments for measurements of the sort described in the paper and expert observers who could at least supervise the observations made by the engineer or owner himself. It seems quite probable that in the future we may expect to see a number of such tests made on newly completed buildings.

The Comparative Merits of Functional and Geographical Systems of Organization.

On another page of this issue we print a paper describing the new plan of organization for city engineering work in Boston devised by Mr. L. K. Rourke, who was recently in charge of the excavation work on the Culebra Division of the Panama Canal under Col. Gaillard.

The author of this paper, after describing the plan of organization adopted for Boston, draws a parallel between it and the plan of organization adopted on the Culebra Cut work and then proceeds to praise the "Geographical" system of organization and to condemn the "Functional" system.

To illustrate what the author means by these terms: On the Culebra Cut excavation work as organized originally, under the "Functional" system, there were separate Superintendents of Tracks, of Dumping, of Steam Shovel Work, of Mining and Transportation. This system worked badly because of perpetual conflict of authority and difficulty in fixing responsibility. It was therefore abolished and a Geographical system was adopted in its place, under which a Superintendent of Construction has entire charge of all work of every sort (except train service) within the limits of a certain district. The efficiency of the organization was greatly improved by this change.

This looked like strong evidence in favor of the Geographical system of organization and against the Functional system. It chanced, however, that the very next paper to pass under the editorial eye was a criticism of American railway companies for not adopting the Functional plan in their business. The paper is a part of the testimony of Mr. Henry R. Towne, M. Am. Soc. M. E., before the Interstate Commerce Commission on Nov. 22, in the proceedings wherein Mr. Louis D. Brandeis (of Boston) sought to prove that the railways might save enough money by better management of their business to make any raise in freight rates unnecessary.* We quote as follows from Mr. Towne's testimony:

> I see another field, drawing an inference from my own experience as a manufacturer, in which I believe that the railroad companies have not gone far, and some have not ventured at all; and that is in what has come to be known under the nomenclature of this modern scientific industrial system as functional management. I can illustrate or explain that in a few words, best by reference to a factory or workshop of the average kind and size.
>
> Under old conditions, what was sometimes referred to as the military system, prevailed, in which the foreman or superintendent of each department or room was responsible for everything done in that room—the discipline, the adjustment of wages, the allotment of work, the instructions to the workmen as to what they were to do, and how they were to do it, the inspection of the product of the workmen, and, in fact, everything pertaining to the management of the work in that room was concentrated in the hands of one person, possibly having some assistants.
>
> Under the functional system, on the contrary, the management of one room will be covered by four, five, six, and in some cases even ten, different persons, the responsibility of each of whom runs on functional lines. One man will have to do with the employment of help; another with the adjustment of wages and piece rates; another with the allotment of work, its distribution to the different men and machines, and another with the ascertainment of labor costs, and so on. The functional system, where it has been availed of intelligently, is proving itself over and over again to be the sounder system of the two. It is in line with the specialization in all of the sciences, in medicine, in law, and so on, that a man who devoted his whole time to one single line of study or research or work becomes more skilful and expert in that than if he attempts to diffuse his labors over a multitude of operations. That higher or intensified skill results in the ascertainment of better methods, in the successful application of those improved methods to the operation in the plant where the functional system is in use.
>
> We can see that if the railroads are not already fully availing themselves of the functional system there must be a very great opportunity for them to do so. They could do that in their office work, in their great central administrative offices, which each one of the large systems has to maintain, and in the subordinate offices, which many or most of them maintain at other points, and throughout the operative system, wherever a large number of men are gathered together under one control and for a combined result.

And so, as Mr. Dooley says, there you are! Just as we were ready to condemn the Functional Plan of Organization in toto, on the strength of Panama experience, along comes Mr. Towne to sing its praises!

The moral is so obvious that it seems almost unnecessary to point it out. No one system of organization is best for all classes of work. The civil engineer found salvation by discarding a functional plan of organization just as Mr. Towne, in his factory production, found salvation by installing it. In almost all cases, we believe, a combination of the functional and the geographical systems of organization gives far better results than either alone. The functional system emphasizes the gain to be made by the introduction of specialists; but while the specialist has his great uses, he also has his limitations. We seem to recall an admission by the most distinguished advocate of "efficiency engineering" in this country that it would not pay to install the system he had devised in a manufacturing machine shop employing less than 150 men.

Mr. Towne expressed the belief that railway companies had no gone far in adopting "functional organization." The truth is, however, that railways were the first to adopt the functional organization plan. From the early days of railroading, railways have been organized with departments of maintenance of way, of rolling stock, of traffic, of auditing and finance. As the railways grew, these departments have been subdivided again and again. Specialists have been placed in charge of testing, of air brakes, of signals, of the telegraph, and so on in all the various departments of work which have to be carried on by a modern great railway. Even in the repair shops, where the criticism of the efficiency engineers has chiefly been concentrated, it is a fact that some of our railway companies have been pioneers in the discovery and application of better tools, better systems of organization, and better methods of paying labor.

On the other hand, the railways have found by experience where the functional system of organization is inapplicable. The weak point of the functional system is apt to be division of authority; and in the transportation department of a railway the military system—as Mr. Towne terms it—has prevailed and must prevail. The specialists have their places, too, of course. The Traveling Engineers can show engine-runners how to save coal, and the air-brake Superintendent can see to it that trainmen know how to use and take care of the brakes; but the authority of the Division Superintendent must be none the less complete and unquestioned.

No one pretends, of course, that the present system of railway organization and operation is perfect. On the contrary, railway officers themselves are all the time studying methods for its improvement. One notable experiment of recent date on the Union Pacific system is the assignment of a greater responsibility for executive work to the "functional officers." But to say that railways as a class are behind other industrial organizations in the adoption of economic methods is as wrong as to say any one scheme of organization is better, under all circumstances and conditions, than any other scheme.

*Previous comment on Mr. Brandeis' theories was made in our issue of Dec. 1, p. 600. Mr. Towne's testimony is printed in the December issue of the "Proceedings" of the Merchants' Association of New York.

LETTERS TO THE EDITOR.

The Nicaragua Canal Project.

Sir: I was much surprised at an editorial that appeared in your issue of Nov. 24 reflecting very severely and unwarrantably upon the Nicaragua Canal. I was connected with that enterprise for a considerable time, in a responsible position, and feel it my duty to protest against such reflections as were cast upon that work by the editorial referred to.

When it is remembered that the Board of Engineers referred to did not condemn the project in toto, but only in so far as the estimate was concerned, they holding that the cost would be greater and they criticized some details of construction, but acknowledged that their appropriation would not allow them to make any extended examinations, and they certainly never stated that the scheme was impractical or impossible, as the article referred to would lead one to believe.

Moreover, the Isthmian Canal Commission, of which Admiral Walker was Chairman, and which was known as the "Million Dollar Commission," after examining very minutely all routes and plans that had ever been proposed, reported in favor of the Nicaragua Route, and this was only changed to the Panama, when it was suggested that the work and plant of the French Commission could be purchased for a sum so low that it would turn the scale in favor of the latter route, as far as cost went. Furthermore, Engineering News was, at that time a strong supporter of the project, and one of its editors was a member of the Second Commission appointed by the Maritime Canal Co., to report on the plan, and they confirmed it entirely, except to raise the estimated cost a little above the preliminary estimate made by the company's engineers.

As nearly all the principal characters connected with that enterprise have now gone over to the great majority, it seems rather unkind to attack a project at this time, which has received the approval of so large a number of eminent engineers, and which, without detracting any from the Panama plan, is now known to be perfectly feasible and practical route.

Very truly yours,

J. Fras. LeBaron.

Ipswich, Mass., Dec. 5, 1910.

[In the editorial to which our correspondent

takes exception, we referred to the bill in Congress to have the United States Government guarantee the bonds of a private corporation, the Nicaragua Canal Co. We believe the failure of this bill to pass was most fortunate for the nation regardless of the merits or demerits of the Nicaragua route from the engineering point of view. As to the latter question, experience at Panama during the last half dozen years has been rather illuminating as to what would have been encountered had the Nicaragua route been undertaken. But it is not worth while to revive the discussion of Nicaragua merits and demerits at the present day.—Ed.]

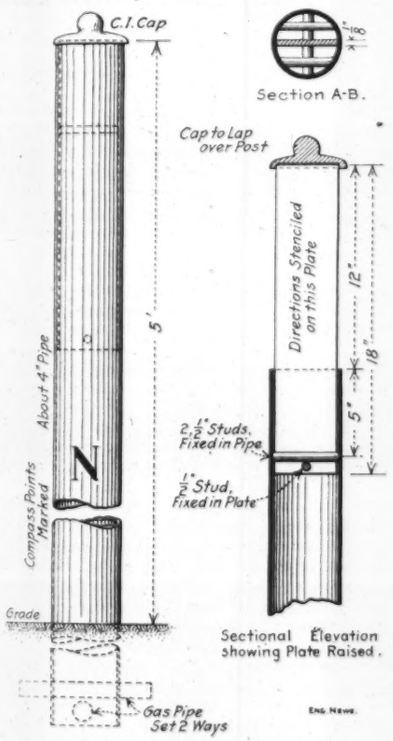
Water Sign-Posts in Deserts.

Sir: The news note appearing in Engineering News of Oct. 6, p. 376, relating to sign-posts for the guidance of travelers in the deserts, touches on a subject of greater importance than the non-frequenter of such places would at first suppose.

Sign posts for this purpose must necessarily be of an indestructible nature, or as nearly so as practicable; they must be of a construction which is practical as well as economical. A little study of how these ends may be obtained is a worthy object of inquiry by the government which erects them.

Wood posts have long proved unsatisfactory, not only owing to the matter of preservation, but on account of the wantonness of a class of people who wilfully destroy them by using them as targets for their marksmanship or otherwise defacing them. Numerous instances of this character have been noted in the California deserts.

A suggestion for such a post as would be nearly indestructible is made by the writer in the accompanying sketch. For the post either new or worn pipe of suitable section, here suggested as 4-in. diam., and of a length of from 8 to 9 ft., could be used. A plate "A," of a size



Suggestion for a Water Sign Post for Desert Use.

to fit the internal diameter of the pipe with a little clearance, about ⅛-in. thick and 18 ins. long, or longer if necessary, is fastened to a cast-iron cap "B," either by bending and riveting it or in some other manner. The cap "B" is so made as to overlap the outside edge of the pipe about ⅛-in. as shown. This would afford protection to the interior plate from the action of the elements.

Upon the plate "A" would be stenciled directions to the nearest water and such other information as might be needful. Two cross-rods "C," fastened rigidly into the pipe and a corresponding rod "D" through the plate, would prevent the plate from being pulled entirely out. As suggested on the drawing, the points of the compass would be placed on the outside of the post, this often being a very essential part in following the stenciled directions of the plate.

The suggested design is readily adaptable to additions or alterations and is marked by simplicity and economy. The writer believes that in the main points it furnishes an appropriate, low-priced and nearly indestructible desert sign-post, and one which could be advantageously used in many parts of the arid west.

L. R. W. Allison.
1353 West 30th St., Los Angeles, Cal.

Has a Contractor a Claim on Old Material Disused as a Result of Construction?

Sir: A contractor doing a piece of work for the writer claims that when erecting new work which interferes with existing structures, the material which goes to form these interfering structures is his in the absence of any specific clause in the contract or specifications disposing of the said material. By his contract he is required to furnish the labor to remove such obstructions and to build the new structure as per plan and specifications which clearly show the work.

For illustration, it is desired to extend a brick building and make it longer than at present. Contractor claims that the brick, in the outside wall, which is to be removed after the extension is complete, are his to dispose of as he sees fit.

This latter case is not really parallel with the first, but contractor claims material in both, saying that no provision is made for disposing of the material and it is common custom to allow this.

It looks to me as though the original owner of the material still retains ownership under the above conditions and I would be pleased to have your valuable opinion on it.

Very truly yours,

H. M. C.

[We cannot speak as to custom or usage in this matter; but it seems probable that if the custom has grown up of giving a contractor the right to dispose of the old materials, it is merely because this old material is ordinarily of so little value that the owner has not bothered himself to claim it.

The case can be made clearer, perhaps, by illustration from a different branch of engineering. Suppose a contractor were to furnish and instal larger engines or boilers for a power station. The old boilers or engines displaced would not belong to the contractor.

Similarly in the case cited by our correspondent, suppose that in the portion of the building affected by the enlargement there were several good steam radiators which were, however, to be displaced by radiators of a different pattern. The contractor would have no right to the displaced radiators, and we cannot see why he should have a right to claim the brick in the old wall.—Ed.]

A Bridge Wrecked by an Automobile.

Sir: The accompanying photograph shows a bridge of 85-ft. span, which, on Nov. 4, 1910, fell into the Naugatuck River as a consequence of being struck violently by a heavy motor car, described as an "automobile bus." As commonly reported, a party of young men were being driven rapidly at a late hour on Nov. 2 along the highway, which makes a rather sharp turn at one end of the bridge. The car, either from skidding or unskillful guidance, left the center of the roadway and collided with an end post of the bridge. The car was wrecked and the end post forced off the bridge seat. None of the occupants of the car is known to have been much damaged, an illustration of the survival of the old law under which persons unusually exhilirated or endowed with less than normal intelligence are popularly believed to receive special and peculiar protection. After the remains of the car were extracted (Nov. 4) the bridge gently settled into the river, closing a useful road.

This incident might well be brought to the attention of designers of light highway truss bridges, as illustrating the need of better anchorage and bracing for the feet of end posts, so that such shocks shall not drive them from their seats on abutments or piers.

R. A. Cairns.

Waterbury, Conn., Dec. 9, 1910.

[The double-parabolic type of bridge raised up on end pillars, as represented in this instance, was built very extensively for highways a quarter of a century ago. In short spans the economical height does not give room for end portal bracing; the grave deficiency in lateral rigidity and strength has long been recognized. In the accident reported by Mr. Cairns the result is very obviously chargeable in large part to this weakness. However, the light low-truss highway bridges built at the present time are little better off, as is evident not only from the type of design but also from the rather startling number of failures of these bridges within the past three or four years. Mr. Cairns' very proper warning could be supplemented by the injunction that

Double-Parabolic Bridge of 85-ft. Span Over the Naugatuck River Above Thomaston, Conn.; View Looking Downstream.
(Wrecked by an automobile Nov. 2, 1910; fell Nov. 4 when automobile was pulled out.)

provision should be made of sufficient stiffness or bracing in the top chord to make this member as strong as the rest of the bridge under normal conditions and in the more common kinds of accidental attack.—Ed.]

Two Theories of Government: The Rio Grande Reclamation Project.

Sir: Referring to the letter of Clarence T. Johnston in your issue of Oct. 6, and Mr. Geo. M. Bacon's reply in your issue of Oct. 20, 1910, the writer is in accord with Mr. Johnston's statement of the case.

The administration of the new conservation policies is based on the theory that the Government should do everything not forbidden by law to make conservation effective. The activities of our public servants are no longer to be limited by what the law directs. The danger in this new theory is that the law does not exclude theories which, in practice, may become injurious. Our welfare is made dependent on the wisdom of the administrative officers of government.

Moreover, this new theory encourages unwarranted interpretations and even violations of the law. This has been illustrated in some of the work of the Reclamation Service, which has taken possession of private enterprises for the development of private property where private enterprise and capital were available. This is contrary to the intent of the Reclamation Law. The latter did not specifically forbid and the operations of the Service were unwarrantably and unnecessarily extended, thereby creating a deficit of $30,000,000 in obligations for uncompleted work, and leaving the Service bankrupt and unable to carry on its legitimate work of reclaiming the desert public lands for homes for the homeless of limited means.

The Salt River Project and the Rio Grande Project are cases in point. In each, the Reclamation Service has spent, or is spending, millions of dollars for improved systems of irrigation for lands held in private ownership, and irrigated for years before the advent of the Service. In each case, the United States took possession of and purchased or confiscated large private irrigation enterprises. In each case, much of the irrigated or irrigable lands are held by speculators, who are not farmers, and who now hold the lands for sale at prices ranging from $100 to $500 per acre. The land owners under both of these projects are generally well to do, have good homes and are not in need of governmental assistance except as a means to increased wealth. In neither case does the poor and homeless family have an opportunity. Each is a rich man's proposition.

The Salt River Project includes and surrounds the populous and wealthy city of Phoenix, Arizona. In like manner, the Rio Grande Project includes El Paso, Texas, the metropolis of the Southwest.

From a wise conservation standpoint and in view of

the financial inability of the Reclamation Service to cover all of its legitimate field of work, such projects as the Salt River and the Rio Grande should have been left to their own ample resources and to development through private enterprise. Otherwise, these projects are splendid examples of irrigation development.

In the Rio Grande Project, the Reclamation Service enters the State of Texas where there is no public domain. It required an act of Congress to validate this.

The Service is prostituted to a foreign field of operation because the United States, under this project, will deliver to Mexico, through the Reclamation Service, 60,000 acre-feet of water annually, without cost to Mexico, but at the expense of the irrigation needs of the upper Rio Grande basin.

The attitude of the Service was of weight in bringing about the treaty under which this water is given to Mexico, notwithstanding an existing and uncompromisingly adverse opinion of the Attorney-General of the United States. To guarantee this water to Mexico and to greatly extend to irrigated area on the American side and to create new irrigation rights under this project, the Reclamation Service has decided and the Interior Department has ruled that it is necessary to bring all of the otherwise unappropriated waters of the Rio Grande in Colorado and Northern New Mexico to the Rio Grande Project; and Colorado is now denied the right of further material appropriation from the Rio Grande in order that the water may run to Mexico.

In the celebrated case of Kansas vs. Colorado to enjoin the latter from use of the waters of the Arkansas River, the United States Supreme Court wisely held that inasmuch as Kansas had failed to establish actual damage to herself, Colorado was not estopped. In the Rio Grande Project, the Interior Department has reversed this most fundamental rule of law. In some of its phases, Conservation has placed itself above the law.

The Reclamation Service presents one of the most commendable forms of conservation; but the demands of private interests have been sufficient to divert a large part of the reclamation fund to channels not altogether legitimate. This is not necessarily a criticism of the personnel of the Reclamation Service. It may have had to do certain things through mandate of higher authority. The Service has not been free of the lobbying of special interests such as ordinarily accompanies appropriations for river and harbor improvements.

In another aspect of conservation as applied, overmatured trees 200 to 400 years old are falling to decay because the Government instituted an untenable action against the owners.

In another case, an entire division of a transcontinental railway service was in imminent peril of being put out of business through cancellation of the permit across a forest reserve for the pipe line on which its entire water supply was dependent. The official order at Washington was in the final stage of completion on misinformation from a subordinate Federal officer before the railroad company was aware of the impending calamity. The Department corrected its error when put into possession of the truth.

We are adjured to, "Save the water power for the people"; "Save the coal for the people"; "Save the timber for the people"; "Save our national heritage, the public domain, for the people." Very well, but how is it to be done? What does it mean? How long are these things to be kept in cold storage? Is the Government going to turn contractor, millwright, manufacturer, miner, lumberman and farmer and disburse dividends to 90,000,000 stockholders? The writer confesses to a vague and distant interest in one ninety millionth part in the fir trees of Oregon and the water power of the Carolinas. It is repugnant as savoring too much of socialism.

The writer believes in placing the resources of the country in the hands of its people who are able and willing to develop them under proper regulation. This development and use will be controlled by the law of supply and demand. Nobody is digging coal or cutting timber just for the fun of doing it or because of any diabolical desire to destroy. We have been making a necessary use of our resources in the wonderful development of our country and we must continue to do so. There has not been as much waste as our more radical conservationists imply.

Except for purely governmental and public uses, the writer believes that the Government should not own a water power, a ton of coal, a forest of timber, or an acre of land longer than necessary to place these things into the possession of citizens of the country as individuals or as associations of individuals under proper conditions and regulations. He does not believe that the Government should do anything for the people which they can do for themselves. Individual incentive, initiative and enterprise are the foundation of our national greatness and well being.

The natural difficulties against development in the arid West are sufficiently great without being augmented by onerous artificial restrictions. The tendency of legislation and governmental administration should be a compensation against the unavoidable natural difficulties. They are at present, the reverse. The development of the arid West especially requires association of individuals, aggregation of capital and pooling of nature's resources.

Retention in government ownership and the leasing system will increase the cost of production and the final price to the consumer, while the expenses of the governmental bureaus will largely counterbalance reasonable revenues. Every proper end can be attained by fair regulation of the selling price of public commodities where a monopoly exists.

Yours truly,

J. L. Campbell, M. Am. Soc. C. E.

El Paso, Tex., Oct. 25, 1910.

[Our correspondent says "the new conservation policies are based on the theory that the Government should do everything not forbidden by law to make conservation effective."

Let us state the question in a little different terms. The question is whether an executive officer in carrying out a law is to do exactly what the law directs and no more, or whether he should go forward with intelligence and discretion to carry out the *spirit* of the law and perform any acts necessary to that end, so long as they are not forbidden by law?

Of course as our correspondent suggests, abuses may arise from such use of executive discretion; but must we not run that risk? Is it not far better to run that risk than to adopt the other policy and rule that an executive department is tied down to the letter of the act under which it operates?

It seems to us that the "strict constructionist" theory makes the Executive a mere tool to carry out the instructions of the Legislative branch of Government, rather than an equal and coordinate power. And further, it needs but the slightest knowledge of the way in which laws are actually framed in Congress or in any Legislature to realize the impossibility that any legislative body, no matter how wise and how honest, can advantageously legislate on matters of detail.

In fact one of the greatest reforms needed today is that legislative bodies shall let the petty details alone, and shall devote all their attention to the really important and fundamental issues.

To take a concrete case: The Reclamation Law was a general act. It did not and could not specify each step that should be taken, in carrying it out.

If it had been attempted to limit the work to just what was stated in the letter of the law, would our correspondent himself like to have had the responsibility of carrying that law into effect and producing beneficial results? Again, Congress did attempt to go into details in one matter. It was more or less infected with the idea (which Mr. Johnson has supported in these columns) that the people of each State are the real owners of the natural wealth of that state even though the Federal Government still retains the title. So Congress ruled that each State should be entitled to have Reclamation work done within its borders in proportion to the revenue from the sale of Federal lands in the State. The Reclamation Service has attempted to carry out in good faith the spirit and letter of this requirement, and has been visited with no end of criticism and curses in consequence, one example of which is the criticisms of the above letter.

Our correspondent speaks of Mr. Pinchot's and Secretary Garfield's position regarding the duties of an executive officer as "a new theory." We fail to see anything new in it. It is as old at least as John Marshall. And if our correspondent hesitates to trust "the wisdom of the administrative officers of Government," the question arises whether the legislators who sit in our state and national capitols have greater wisdom and integrity and are any more to be trusted.

Is it not the wiser, the true conservative course to trust each in the proper sphere? To declare that an executive officer should be held down to just the activities that Congress prescribes, appears to us about like saying that the Chief Engineer of a railway company should not do anything but what he is told to do by the Board of Directors.

We could say much in reply to Mr. Campbell's argument that the Government should not have undertaken the Salt River Project and the Rio Grande Project, but should have left them to private enterprise; but it doesn't seem necessary to take the space. It does not take a very long memory to recall the historical fact that the Government was practically forced to take up irrigation work in the West by an overwhelming public demand because the work of irrigation by private enterprise had broken down. The success of the Government Reclamation work has given irrigation by private enterprise a new lease of life; but even to-day it would not be possible for private enterprise to finance such works as the Roosevelt dam or the great dam to be built on the Rio Grande. The latter work, moreover, is being built by the Government to fulfil our moral and legal obligations to the riparian land owners on the lower Rio Grande. It would be nothing short of a national disgrace if we did not undertake and carry out this work.—Ed.]

Annual Convention of the National Association of Cement Users.

Up to the Sixth Annual Convention of the National Association of Cement Users, held in Chicago, Feb. 21-25, 1910, at each annual convention the Association had provided a special exhibition of cement products and machinery in connection with the convention. At that time, however, it was thought best to avoid the immense labor and expense connected with such an enterprise and to hold the convention at the same time and in harmonic relations with the Cement Show, which had annually been given at Chicago. This winter the management of the Chicago Show decided to give an additional exhibition in Madison Square Garden, in New York City, in December, beside the regular February Chicago Show, and it was with this exhibition as an additional attraction that the Seventh Annual Convention of the Association was held Dec. 14 to 20, 1910, with sessions in the Concert Hall of Madison Square Garden and the exhibition in the main hall of that building. It thus happens that the year 1910 sees two of the "annual" conventions of the Association.

As has been the case with this convention for some years past, the program was very extensive. There were scheduled 44 papers, four topical discussions, each lasting over a one-and-a-half hour period, and six committee reports. For the consideration of these papers and reports, ten sessions were scheduled extending over six days; two on each day of the week except Thursday, on which evening there was a banquet, and on Saturday. As a consequence of running behind the schedule, it became necessary to add two more sessions, so that on two of the days there were meetings at 9 a. m., 2 p. m. and 8 p. m. As there were no simultaneous sessions, the continued attendance by any member on all meetings was generally out of the question, not only on account of the tax on the endurance of the member but because also of his desire to see something of the Exhibition.

As we have remarked before, the work of this convention is done in three ways: by topical discussions led by some appointed member on matters of practical interest to concrete workers; by the reading and discussion of papers prepared on some appointed subject, and by the discussion of committee reports. These latter have until this year generally taken the form of specifications submitted by the committee, which specifications were fought over on the floor of the convention and either returned to the committee or adopted to be sent to the letter ballot of the association. On account of the great divergence of practice in concrete work, it has been found that the establishment of standard specifications was extremely difficult, so that gradually the Association, through its committees has become impressed with the idea that it is not so much its duty to establish hard and fast specifications, which are not the practice of a large number of its members, but rather that it should, through its committees, submit so-called "recommended practice," which might be taken as the best standards that a young and changing industry can have, so this year out of the six committees reporting only one submitted a specification. The others filed either reports or recommended practice.

Committee Reports.

ROADWAYS AND PAVEMENTS (C. W. Boynton, Chairman).—This committee reported no addition to its specification of last year. The chairman said that although there was probably a field for a specification which would provide a dustless floor, he thought that there was no consensus of opinion on this matter and that it would be better to wait another year before attempting any standardization.

REINFORCED CONCRETE AND BUILDING LAWS (Albert E. Lindau, Chairman).—The principal report of the committee was an account of the varying cost of a standard concrete building under the building laws of some five different cities. The committee outlined a concrete building of ordinary standard construction, and then designed this building under the building laws of the cities of New York, St. Louis, San Francisco and Chicago, and also under the specifications of several technical associations. It was shown that the costs of the concrete work would vary very considerably due to the different specifications. For instances, the building under the San Francisco specifications would cost $37,861, while under the St. Louis specifications it would cost only $33,161—an 11% variation. This variation, the committee thinks, should not exist, and will not exist, if the association is able in the future to establish a good standard which the cities will adopt.

The committee announced that it would be very glad to assist in any full-size tests of buildings which an owner or engineer might care to make by sending instruments and observers to the building to help the work.

SPECIFICATIONS FOR CEMENT PRODUCTS (P. S. Hudson, Chairman).—This committee submitted proposed standard specifications for architectural concrete blocks, which did not meet the entire approval of the convention. They were accepted as tentative in order to be printed in the Proceedings and with the hope that during the next year enough suggestions would come in to allow the committee to prepare a more acceptable specification. Following the work of last year, the committee also submitted a recommended practice for plain concrete drain tile.

TREATMENT OF CONCRETE SURFACES (L. C. Wason, Chairman).—This committee last year submitted a very extended report on the treatment of concrete surfaces, which was reprinted in Engineering News, Sept. 15, 1910, p. 291. This year its report consisted of additions to the recommendations of last year. These additions consisted of the specifications for pigments which are to be added to make various colored concretes, a specification for dry rubbing and some suggestions as to stuccoing. In this latter matter the committee has, from a series of experiments, found that when quicklime was used in stucco work about three-quarters as much should be used as of hydrated lime. A section on waterproofing was also added. The various exterior waterproofing compounds are divided into three classes; those that are clear and do not change the surface of the concrete, those that have a body like paint giving a pleasing color to a surface and those of a tar-like nature which deface the surface, so that they could not be used in any work where good looks are necessary. As a result of experiments, which, it should be said, were criticized somewhat severely on the floor, the committee is not particularly impressed with the efficacy of the clear paints as waterproofing agents; nor does it think that the colored paints are as effective as some other methods of waterproofing. It does, however, consider that the tar-like waterproofing coatings are effective in repelling water under certain conditions where they can be applied and where an artistic effect is not desired. In regard to the integrally-mixed waterproofing compounds, the committee thinks that most of their effectiveness is due to thorough mixing with the dry aggregate and that in many cases an equally effective result can be reached by such thorough mixing of the aggregate without any further waterproofing compound.

On behalf of the committee, Mr. H. H. Quimby submitted a specification for scrubbed surfaces under the method which he devised some years ago, and which has proved so very successful. This specification, which is reprinted in another page of this issue, was accepted by the convention and sent to the letter ballot of the association.

A specification on stucco was submitted and returned to the committee by the convention, with a proviso that it be printed in the Proceedings, for discussion during the year.

FIREPROOFING (Rudolph P. Miller, Chairman).—This committee made no report this year; at least, none was presented to the convention.

INSURANCE (W. H. Ham, Chairman).—This committee is engaged in an extensive study of the relation of insurance rates to concrete structures and presented an extensive report on this subject, which we hope to abstract later.

Papers.

FIREPROOFING AND FIRE PROTECTION.—The address of the President, Mr. Richard L. Humphrey, was this year devoted to a lecture on the fire hazards of construction in America. The lecture was illustrated with a number of views of some of the disastrous conflagrations of the past decade and with examples of the various types of construction which had failed under the severe conditions of these conflagrations. The views showed to an exceptional degree the extent of damage which a supposedly staunch structural member may suffer when subjected to intense heat.

The president was followed by Mr. William H. Merrill, President of the National Fire Protection Association, who read a paper describing the work of that association. Mr. Merrill showed in very condensed form the actual loss from fire in the United States at present—a loss which must come directly from the resources of the country, no matter how it is distributed by insurance payments over the more fortunate owners. The association of which he is president has for its work the developing of a greater care among builders, owners and city officials in construction, so that the loss from unavoidable fires may be reduced. In this work the association has a number of engineers who are investigating all subjects of fire protection, and its regular bulletins are among the best literature upon the subject to-day.

SOME THERMAL PROPERTIES OF CONCRETE.—Under this title, Prof. Charles L. Norton, Professor of Heating Measurement of Massachusetts Institute of Technology, read a paper describing the tests made under his direction at that institution. He has now for some three years been investigating those properties of concrete which would render it of value in fireproof construction, and, although no where near the end of his studies, has reached a place where there is considerable value in what he has learned. In discussing his paper the question of cinder concrete as a fire-protecting covering was brought up. It has been shown that cinder concrete containing up to 7% of coal could be successfully used in fireproofing operations, but that where a much larger percentage is present the individual pieces of coal are apt to swell and burn to the detriment of the structure. The reason that cinder concrete proves a valuable fireproofing agent is because the heat transmission through it is exceedingly small as compared with the heat transmission through stone-concrete or stone. There should be, however, great care taken that the amount of free coal in the cinder is as small as possible.

ACTUAL BUILDING TEST.—Mr. A. R. Lord (Urbana, Ill.) described in considerable detail a test for deformation made upon a flat slab of a reinforced-concrete building in Minneapolis. This paper is reprinted on another page of this issue. Mr. Lord emphasized the fact that this test is important, not so much for the actual results obtained on the particular building under test as for the demonstration of the possibility of making on existing buildings tests that will give some idea of the stresses existing in the building under slightly supernormal loads.

Mr. E. G. Perrot gave a tabular statement, with explanation, of the results of a number of full size deflection tests of concrete buildings made by his firm in the past few years.

CALCULATION OF FLAT SLABS.—Mr. Lord also read a paper (originally to have been prepared by Prof. A. N. Talbot, and so scheduled) entitled "A Discussion of the Basis of Design for Reinforced-Concrete Floor Slabs," in which he presented some views of the flat-slab theories deduced mainly from the full-size experiments noted immediately above.

MILL BUILDING VS. REINFORCED CONCRETE.—In a paper entitled "Comparative Cost of Maintenance of Various Types of Building Construction," Mr. J. P. H. Perry (New York City) opened the discussion on the relative costs of the slow-burning mill construction and reinforced concrete. He assumed, in the first place, a building with an original cost of approximately $100,000, and on this basis figured out the relative annual costs of the two types of buildings. It is probable that the first cost of the concrete building would be some 10% greater than that of the mill building. In the maintenance, however, the concrete building would save money on account of the minimum amount of vibration, the ease with which it can be lighted, the reduction in its insurance and its freedom from vermin. The ordinary concrete building has a window percentage of the outside wall of from 70 to 80, whereas the ordinary mill building has only 30 to 40%. This additional window space affords a much lighter interior and thereby allows the workmen to do much more work. Of late, the insurance rates on concrete buildings and on their contents have been much lower than similar rates on mill buildings. In regard to vibration, it has been the experience of owners of concrete buildings that a considerable saving has been noted each year on account of the better condition of the machinery due to the stability and lack of vibration in the concrete building. One owner, for instance, who has similar machinery in a concrete and a mill building, has noted that the maintenance of machinery in the vibrating mill building amounts to some $5,000 a year more than in the non-vibrating concrete building. Finally, in any building with perishable contents the loss from vermin is appreciable, and this loss, it is quite probable, can be avoided in concrete structures where the vermin find it hard to exist.

Assessing to each of these above items an approximate amount based on letters which he had written to some 25 architects and owners, Mr. Perry finds that the annual charges on the two buildings, capitalizing the first cost at 6%, would amount to $11,000 in the case of the mill building and $9,000 in the case of the concrete building.

In the discussion, Mr. W. H. Ham (Boston) said that in a specific case he had observed that in the summer the temperature in a concrete building was some 10° lower than in an adjacent mill building and in the winter some 10° higher. While the difference in temperature in the winter probably made small difference, as the building was heated from waste steam, the lower temperature in the summer certainly added considerably to the capacity of the workmen. Mr. Walter F. Baillinger (Philadelphia) stated that in his observation this lowering of summer temperature and raising of winter temperature was not true for concrete buildings, but it was noted afterward by another speaker that once the building were heated in winter the amount of heating necessary to maintain an even temperature was considerably less than in a wooden building. Mr. Ham further noted that the companion of mill buildings with concrete buildings should take account of the fact that mill buildings are generally designed for light loads, say, 60 lbs. per sq. ft., whereas, in most cities the lowest load for which the regulations allow a concrete building to be designed is 150 lbs. per sq. ft. He also noted that concrete buildings can have longer floor spans than mill buildings, which sometimes brings about a saving in the disposition of the machinery. Mr. L. C. Wason said that in his experience Mr. Perry's assumption that a concrete building would cost 10% more than a mill building did not always hold. He had found that for loads under 200 lbs. per sq. ft. the mill construction was cheaper, but for loads above that amount the reinforced-concrete

was as cheap or cheaper than the mill construction.

DUSTLESS CONCRETE FLOORS.—This discussion was opened by Mr. L. C. Wason of Boston. He divided his remarks into three sections (1) what causes dusty floors, (2) how to avoid them, and (3) how to remedy them. The cause of dust on a floor is the abrasion of the surface; that is, the wear of one kind or another which loosens the surface particles. All floors are dusty, but the harder the surface the less dust will form. Natural stone is much harder than concrete, and therefore dusts considerably less. It is evident, then, that to procure a dustless floor the surface must be made up of as large a percentage of stone as possible, and the finer particles must be kept out of the mix. With care, at least 90% of a concrete floor surface can be of stone, even though that stone be as small as the ⅛-in. diameter, which has been found to be about the right size. Mr. Wason advised that no sand be used in concrete floor surfaces, but only run of crusher stone between the sizes of 1/20- to ½-in., rejecting all flour, and using a 1:1½ or a 1:2 mix. If this is thoroughly mixed and laid, not so dry as to allow the surface particles to be rubbed out when it is set, nor so wet as to flush the finer particles to the top, a dustless floor should result.

Two methods are available for stopping the dusting of floors already built: (1) to apply a boiled linseed oil coating, or (2) to apply a water glass or sodium silicate coating. In the discussion it seemed to be the concensus of opinion that there was altogether too much working of the surface material in concrete floors. The last of the successive trowelings which are common is about to take place after the concrete has taken its initial set, and, therefore, tends to reduce the strength. It was also stated that if a thin ¾-in. surface layer of concrete is placed on a concrete floor already set failure might be expected. When the surface is put on after the bottom is set, the thickness should be much greater.

Mr. J. B. Landfield (Binghamton, N. Y.), in showing some views of some metal forms for sidewalk and curb construction, stated that it was his opinion that floors and sidewalks of concrete should be tamped hard and should not be troweled to make the surface, as is usually done. The forms which he showed were made of steel channel sections lengthwise of the pavement, with intervening flat plate cross bars to form the expansion section.

A CONCRETE-PROTECTED WATER TANK.—Mr. Emil G. Perrot (Philadelphia) read a paper entitled "An Incident of Value of Concrete in Reducing the Cost of Insurance." Mr. Perrot's firm had occasion recently to build, in the city of Camden, N. J., an elevated water tank resting upon a tall structural steel tower. This tank was in the heart of the city immediately adjacent to two business properties, the owners of which were somewhat fearful of the disastrous effect which might follow an adjacent fire and the possible collapse of the tower. It was found that the insurance rates on this structure, with its unprotected steel column legs, would amount to about $500 per annum. It was figured, however, that each of the columns and horizontal members of the tower could be encased in concrete at a total expense of $4,000. This fireproofing was thereupon done. It will be noted that the $4,000 cost of fireproofing means an annual expense of $240 at a 6% interest rate, whereas the insurance of the tower would have cost $500. In addition, it is probable that the tower is so fireproof that a fire in one of the adjacent buildings would not harm it, although, if it had been left unprotected, the damage to the surrounding structures might have been very great. The total cost of the tower, with its fireproofing was about $13,000.

CONCRETE-FILLED STEEL ARCHES.—Mr. H. H. Quimby (Philadelphia) gave an illustrated lecture on the Forty-Second Street Bridge across the Pennsylvania tracks in Philadelphia, Pa. This bridge, which was described in Engineering News, May 20, 1909, is a long span arch made up of two steel arch ribs of box section, the peculiarity of it being that the box section is filled tight with concrete. The roadway is of reinforced concrete suspended by steel channels from the arch above.

THE AZISCOHOS DAM.—Mr. Seth A. Moulton (Portland, Me.), read a paper upon "Some Construction Problems of the Aziscohos Concrete Dam." This dam is a hollow concrete structure built across the Androscoggin River at the foot of one of the group of lakes in the Rangeley Lake region in Central Maine. It forms a reservoir for water storage for use of a number of mills on the lower Androscoggin. There are three points of interest in the dam and in its construction: (1) its remoteness from a base of supplies; (2) the arched deck slab, and (3) the log chute. The dam site is some 38 miles from the nearest railroad station, and all material had to be carted in over the ordinary log roads of central Maine, which are none too good for heavy teaming. The best estimate the engineers could get from local teamsters showed a total amount of material possible to be hauled to the site much lower than would be required for the summer's work. However, the engineers prepared a schedule, and by careful arrangement of stopping places and an unusually complete time-card for the trip managed to carry into the plant during the past summer about twice as much as had been predicted. The dam itself is a buttressed concrete dam with the deck, instead of being flat slabs, as is common in this type, consisting of solid arches spanning the 20 ft. between the buttresses. There was plenty of lumber on the site, so that the construction of forms was fairly cheap. However, a system of re-usable forms was designed, which proved very successful. This river is very largely used for logging purposes so that some provision had to be made to carry the logs over the dam. For this a suspended chute was built. This chute consists of a steel truss bridge hanging by counterweighted chains from a sluiceway in the dam and resting on a solid roller-bearing base below the dam at a much lower elevation. The whole work is not yet completed.

HANDLING CONCRETE.—Mr. H. M. Cryder, in a paper entitled "Preparation and Handling of Concrete," described a number of installations which his firm had used in the handling of concrete on large construction jobs such as bridges and bridge foundations. He said they had found that the most economical method of conveying the cement, sand and stone from their respective bins or piles to the mixer was an endless belt-conveyor system. There are very often difficulties in arrangement which preclude possibility of the use of this device, but where there is ample room for storage the facility with which the materials can be loaded upon this traveling belt make it admirably adapted for conveying the aggregate.

CONCRETE BLOCKS AND TILE.—Mr. C. M. Powell (Chicago, Ill.), described a typical and model cement tile plant which had been designed in the middle West. Heretofore the design of these plants has been hardly as scientific as it should be, with the result that the profits have been small, but it is Mr. Powell's opinion that if as much thought is put upon such a plant as is generally put on any other factory the results will well warrant the possibly greater first cost.

Mr. C. D. Watson (Syracuse, N. Y.), in an address advocated a better system of cost keeping amongst concrete block and tile manufacturers. He said that, owing to the loose bookkeeping, many block manufacturers do not know that they are bankrupt. He had no specific methods to advise, but recommended that the matter be taken up by the association for further study.

PUZZOLAN-PORTLAND CEMENT.—In a paper by Mr. Joseph B. Lippincott (Los Angeles, Cal.), the advantages of the Puzzolan Portland cement now being used on the Los Angeles Aqueduct were set forth. Mr. Lippincott's paper contained practically the same information as was given in the paper by Mr. Edward Duryee in Engineering News, Dec. 1, 1910, so that it will not be abstracted here.

CONCRETE IN SEA-WATER.—Mr. R. Baffrey (New York) described, in a paper entitled "Use of Reinforced Concrete in Sea-Water," a considerable number of reinforced-concrete structures which had been built in the seas and ocean surrounding Europe. As is perhaps well known, such marine structures are far more common in Europe than they are in this country, and their existence in fair condition shows that concrete can be used in sea-water when properly mixed and placed. Suggestions have been made often that either puzzolan or iron-ore cement should be used for sea-water construction, but Mr. Baffrey says that in this country, except on the Pacific Coast, such cements are difficult to obtain and very costly. He, therefore, advises that the only proper protection for sea-water construction is a graded aggregate and a careful mix and composition.

In the discussion, Mr. Rudolph Wig (Atlantic City, N. J.), reported several results of the tests which have been made by the United States Government at Atlantic City. These tests are only two years old and have not reached any definite stage as yet. He said, however, that as a rule the laboratory results on small specimens were poor, whereas the large-size tests of blocks in the sea showed up fairly well.

ELECTROLYSIS OF CONCRETE.—Mr. C. M. Chapman (Westinghouse, Church, Kerr & Co., New York), read a paper entitled "Effective Electrolysis on Metal Imbedded in Concrete," which described a rather limited series of tests conducted by him. He had blocks of stone-concrete 6 × 8 × 48 ins. in size, in which were imbedded eleven flat plates of thin metal about 2 ins. wide, the upper part of the plates projecting from the 6-in. surface of the block. These blocks were placed in shallow pans and subjected to a current of 10 volts and 0.2 amp., three blocks being arranged in parallel across the line. At the end of three weeks small bubbles began to appear at the lines where the plates emerged from the concrete, and soon cracks commenced to appear on the edge of the blocks in line with the plates. The blocks were easily broken open along these cracks, and it was found that the concrete was hard and sound, except near the plates, where it was soft, and where iron rust was evident, though this rust did not extend far into the concrete. Some of the plates had been treated with insulating paints previous to being inserted in the concrete, and this paint seemed to have come off partly on the concrete, though the effect of the electrical action on the painted and unpainted plates was not very different. Following these tests, 200 of which were made, two round blocks were made, in one of which an iron rod was inserted and in the other a carbon rod, and the tests carried on precisely the same in the two blocks. Under 10 volts of direct current the iron rod burst in one week, but the block with the carbon rod showed no signs of change in two months, when the voltage was raised to 30, then 50 and finally 85 volts, all with no apparent effect. In view of the fact that the only difference in the action on the block with the iron rod and the one with the carbon rod was that the iron rods rusted while the carbon rods did not, the author concludes that the fundamental cause of deterioration of concrete containing iron rods subjected to electrical current is the swelling of the concrete immediately surrounding the rod, due to the formation of rust.

THE CEMENT GUN.—Mr. G. L. Prentiss (New York) read a paper entitled "The Use of Compressed Air in the Handling of Mortar and Concrete." This paper, while treating slightly the general subject named in its title, was more particularly a description of a machine known colloquially as the "cement gun," which is used to squirt concrete mortar in stucco form upon any kind of a surface. The construction of this machine consists of a gasoline engine-driven compressor mounted on an automobile truck, with two tanks; one for holding the dry cement and sand mix (which in the present machine is to be mixed outside), and one for holding water, both of which tanks are under pressure from the compressor. The machine differs from all other grout or mortar pumping machines in that the dry cement and sand are pumped through the pipe to within an inch of the nozzle, where there enters the pipe carrying the water under pressure. The mix of the cement and sand and the water is made, then, in the inch distance between this pipe entrance and the nozzle orifice. Strange

as it may seem, this mix is remarkably thorough and the concrete or mortar grout reaches the surface to which it is to be applied in very complete combination. One of the machines was exhibited in the show, and showed very conclusively that a concrete, or, rather, mortar, face could be built up on any surface with great rapidity and with a very solid resulting structure.

HUDSON MEMORIAL BRIDGE.—Prof. William H. Burr (New York) described in an illustrated lecture the design of the proposed Hudson Memorial Bridge across Spuyten Duyvil at the north end of Manhattan Island, N. Y. This bridge, which was described in Engineering News, Nov. 21, 1907, p. 559, has as its main member a central concrete-steel arch of 703-ft. clear span. Prof. Burr did not state whether there was any immediate prospect of building the bridge, nor did he explain how it was intended to overcome the many known difficulties in its erection.

WATERPROOFING WITH WATER.—Mr. C. M. Chapman (New York) presented the results of some tests on the effect of water as a waterproofing agent in concrete. He made a number of blocks 3½ × 3½ × 2 ins. in size of the same initial mix, but with varying quantities of water. In the top of these blocks there was a semi-spherical depression in which water was placed and the time for its absorption was noted. It was found that the blocks made with from 13 to 16% mixing water showed the lowest rate and amount of absorption. Mr. Chapman did not claim that these percentages would hold for all degrees of mix, but did claim that some similar experiments might be made for any desired mix or quality of aggregate, and the proper amount of water to use in the mix could readily be determined.

MEASURING CONCRETE WORK.—In connection with the rules for measuring materials which have recently been adopted at Chicago (Engineering News, Nov. 3, 1910, p. 482), Mr. Robert A. Cummings suggested that some action should be taken by the association to draw up some rules which would be much more satisfactory to the concrete industry than are those from Chicago. He said that the matter of measurement is in a very chaotic condition and that different men make their measurements in different manners, which is not desirable. It was announced that the executive committee would consider this matter and assign it to the proper committee for next year's work.

MISCELLANEOUS PAPERS.—The following papers scheduled on the program were either read by title or had not been received by the management in time for the convention: "The Calculation of Flat Reinforced-Concrete Plates," L. J. Mensch; "The Human Element in Concrete Construction," H. F. Porter; "Use of Reinforced Concrete for Storage Bins," James Macdonald; "Advantages and Comparative Cost of Spouting Concrete," F. E. Engstrum; "Web Reinforcement of Concrete Beams," Peter Gillespie; "Reinforced Concrete Sewers," J. A. Hooke; "Concrete Construction," Alfred Hopkins; "Reinforced-Concrete Construction in San Francisco and Vicinity," J. H. Leonard; "The Insulation of Concrete Structures," E. W. DeKnight; "A Comparison of the Concrete Industry in Europe and America," Dr. Otto Schott.

The Hungarian Society of Architects and Engineers submitted to the associations three of its specifications which were read in abstract and are to be printed in full in the Proceedings of the associations. These were "Specifications for the Design and Construction of Reinforced-Concrete Buildings," "Rules Concerning Uniform Nomenclature for the Binding Materials of the Various Mortars" and "Specifications for the Delivery and Testing of Trass."

Other papers read were "Some Special Uses of Concrete in Coal Mining Operations," George S. Rice (U. S. Bureau of Mines); "The Taylor Coal Breaker," R. D. Richardson (D. L. & W. R. R.); "Some Advantages of Reinforced Concrete from an Architect's Point of View," R. A. McCullough (N. Y.); "The Waterproofing of Tunnels," A. H. Harrison (N. Y.); "Reinforced-Concrete School Buildings," John T. Simpson; "The Relation of the Lime Content of Cement to the Durability of Concrete," H. S. Spackman; "Web Reinforcement of Concrete Beams," John S. Sewell; "Additional Notes on Steam Curing Plants," F. S. Phipps.

Officers.

The following officers were elected for the ensuing year: President, Richard L. Humphrey (Philadelphia); 1st Vice-Pres., Edward D. Bayer (Catasauqua, Pa.); 2d Vice-Pres., Arthur N. Talbot (Urbana, Ill.); 3d Vice-Pres., E. S. Larned (Boston); 4th Vice-Pres., Ira H. Woolson (New York). Mr. H. C. Turner (New York) is Treasurer, and Mr. E. E. Krauss (Harrison Bldg., Philadelphia) is Acting Secretary.

It was reported that there are now 1,048 members, a gain of nearly 200 over last year, and that, although the balance in the treasury is somewhat less than last year, there is still a considerable balance. It is hoped that from now on there will be a profit in the sale of the Proceedings of the Association.

A Test of a Flat Slab Floor in a Reinforced-Concrete Building.*

By ARTHUR R. LORD.†

The most important recent development in building construction is the introduction and rapid extension of the flat slab type of floor. The advantages of this construction, from the standpoint of both the occupant and the builder, are very generally admitted. It cannot, however, hope to receive the full confidence of engineers until the nature of the structural action in such floors is understood. Several attempts at analysis have been made but none have met with any general acceptance. Actual designs in this construction offer some of the most striking contrasts and disagreements to be found in engineering practice to-day. It would seem that, by common consent, we must classify this construction, along with the voussoir arch and the retaining wall, as subjects beyond the range of pure analysis. In the presence of so many unknown conditions as obtain in the flat slab floor no analysis can stand which is not supported by convincing test data. The question immediately arises as to the means by which such tests may be secured most effectively. It is evident that a really satisfactory test of such construction can be carried on in our present laboratories only at a very large expense and at a sacrifice of many of the conditions obtaining in building construction. We may say certainly that such a test as is practical under laboratory limitations would fail to carry the weight among practicing engineers that would attach to a test of an actual structure, in which test laboratory methods and refinement prevailed. When we take our laboratory afield, however, we must recognize the disadvantage arising from the fact that the test may not be carried to destruction. In such a test we may hope to secure information on working stresses only, and we may not be able to determine absolutely the weakest points in our design. We shall, however, obtain many data of great value in a hitherto unexplored field, and one of the most important features of the test described in this paper lies in the fact that it demonstrates the feasibility of making field tests with practically laboratory refinement. A test which shows that it is possible to take precise extensometers into a building and measure the actual deformations which occur in the component parts of the structure as the load is applied or removed has justified its undertaking. When the simple transformation of these deformations into stresses has been made, we shall have at hand most valuable information as a basis of future design. Questions regarding the flexure of the slab at the column capitals, questions as to the extent of "arch" and "slab" action, and the other disturbing elements which separate our analysis assumptions and our actual conditions, are all overcome in the test of the actual structure and the true stresses present in the floor are observed directly.

In this paper such a test for actual stresses in a reinforced-concrete building will be described. The full possibilities of the method have not, of course, been realized in this its first application to building construction. The attempt was made to cover a few of the most essential points thoroughly, leaving many other questions for consideration in future tests when the experience gained in this test may be available for use in determining the best methods. Measurements were taken on the deflection at several points, on the deformation of the steel at the center of the span, on the deformation of the steel over the column capital, on the deformation of the concrete at the edge of the capital, and on the curvature of the elastic surface in two directions. Working without precedents, it was necessary to design new instruments for use on this test and new methods of attachment for other instruments, so that it must be expected that the accuracy of the results was not so great as may be obtained under the best laboratory conditions. As will be shown, however, the stresses were determined within quite narrow limits and the difficulties were found less troublesome than had been expected.

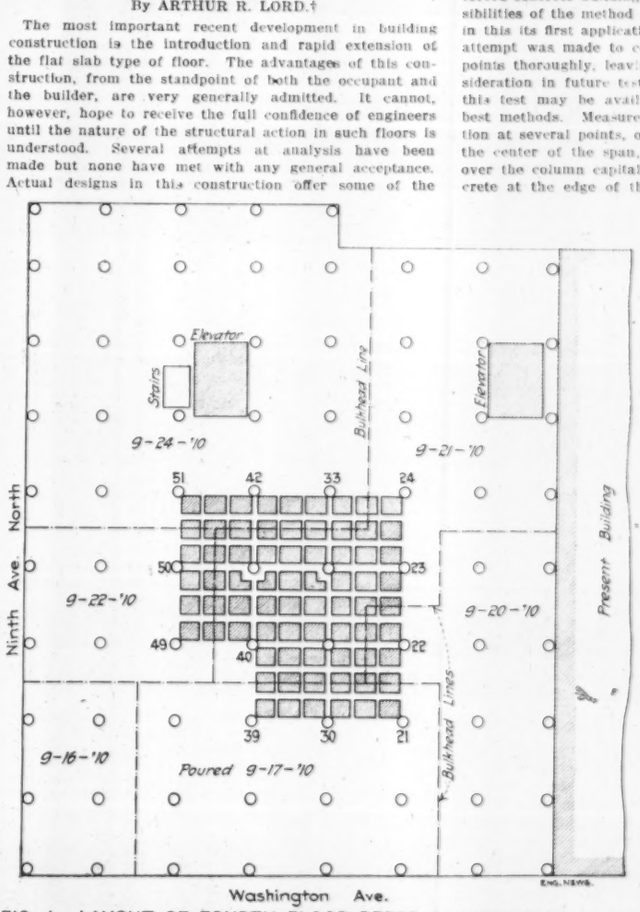


FIG. 1. LAYOUT OF FOURTH FLOOR DEERE & WEBBER CO. BLDG., MINNEAPOLIS, SHOWING POSITION OF LOADING FOR TEST.

The test was made possible through the united action of the Leonard Construction Co., of Chicago; the Concrete Steel Products Co., of Chicago, and the Engineering Experiment Station of the University of Illinois. The building tested was an eleven story and basement warehouse now under construction at Minneapolis, Minn., for the Deere & Webber Co., of that city. Fig. 1 shows the floor plan of the building and the location of the panels loaded. The dimensions of the panels are 18 ft. 8 ins. by 19 ft. 1 in., the slab thickness measuring 9 3-16 ins. A 1:2:4 mixture was used. The floor was designed for a live load of 225 lbs. per sq. ft. and the details of the reinforcement, shown in Fig. 2, are typical of the standard practice of the Concrete Steel Products Co. The floor tested was the fourth from the ground and the conditions were not such as to make a high showing of strength. Owing to a failure in the supply of aggregate during the construction of this floor an abnormal number of bulkhead separations occur in the slab as is shown in Fig. 1. Such separations occur in every panel under load except one. The concrete was only 40 days old at the beginning of the test. In general conditions were such as to give slightly higher stresses than we would expect were the slab well-seasoned and normally poured. In applying the load, care was taken that no serious arch action in the load be possible. In the earlier stages bricks were piled in piers, as shown in Fig. 1, with open aisles from 8 to 16 ins. wide between the piers. Later, cement was used as load, the piers being maintained separate as before. The load given in the diagrams is in all cases the total load on the panel divided by the area of the panel, the *intensity* of load under the pier area being greater.

*A paper presented before the Annual Convention of the National Association of Cement Users, New York City, Dec. 13, 1910.

†Research Fellow in the Engineering Experiment Station of the University of Illinois, Urbana, Ill.

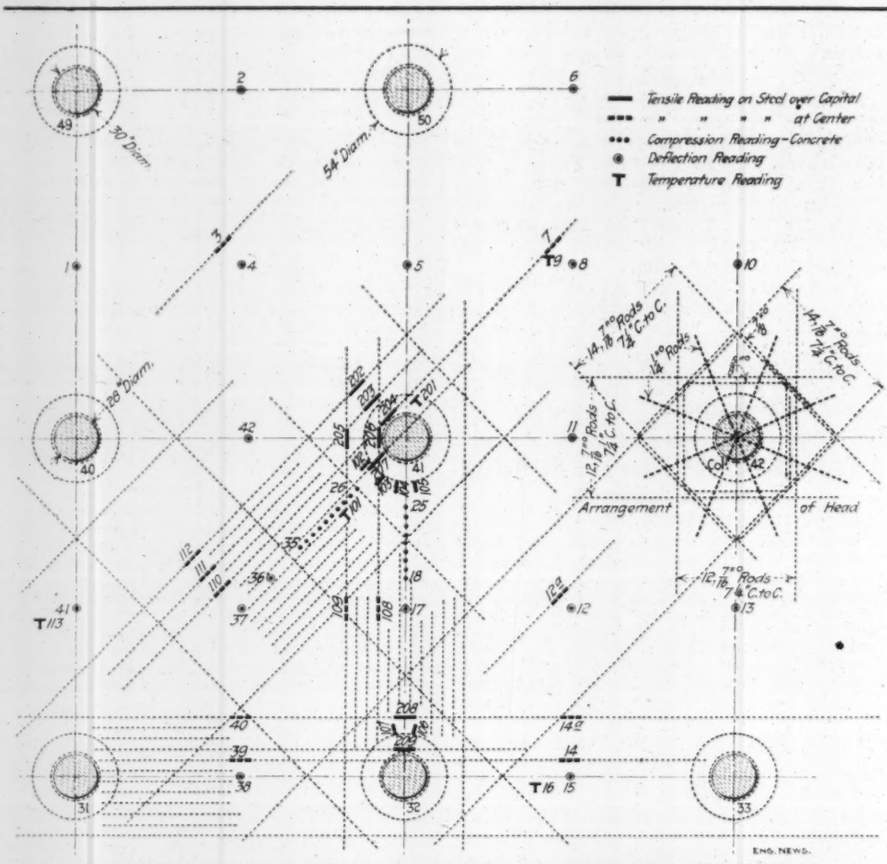


FIG. 2. DIAGRAM SHOWING KIND AND LOCATION OF EXTENSION, COMPRESSION AND DEFLECTION MEASUREMENTS.

Instruments.

[As will be noted from Fig. 2, readings were taken as follows: Extension of steel in upper face of slab over capitals and at lower face of slab at center, compression of concrete on lower face of slab near capital and deflection of slab along right and diagonal column connecting lines. All instruments were either attached directly to the concrete or braced between the concrete and a separate system of falsework from that on which the observers walked.—Ed. Eng. News.]

For deflection the instrument shown in Fig. 3 was used. Polished steel balls were attached to the ceiling at close intervals, and another ball carried immediately below on an upright, and the instrument was inserted between them. Measurements were made in this manner to the nearest 0.001-in. with accuracy. For measuring the deformation in the steel at the center of the span a clamp was rigidly attached to the slab rod (the concrete being removed at one point for this purpose), and a Wissler dial was carried on the clamp (Fig. 4). A fine, silk-covered, copper wire was attached to the rod at distance of exactly 15 ins. from the clamp and passed immediately below the rod, over an idler on the clamp, and then over the drum of the dial. This wire was 1/16-in. below the under surface of the bared slab rod, and the deformations observed were therefore slightly in excess of the actual deformation in the rod. The wire was placed in this position because experience in the laboratory has demonstrated that measurements taken below the slab, depending on the position of the neutral axis for corrections, are subject to considerable error. By this arrangement the deformation was measured to an indicated reading of 0.0002-in. on a gage length of 15 ins. The instrument was less responsive to slight changes than were the other instruments used, an dthe stress in the steel may vary by as much as 800 to 1,000 lbs. per sq. in. from the value observed, which is much closer than we can design for on account of the many unknown factors entering into all design computations.

For measuring the deformation in the steel over the column capital a modification of the Berry extensometer was made (with the permission of Prof. H. C. Berry, of the University of Pennsylvania). The slab rods were first bared at two points 15 ins. apart and very small holes drilled in them. The points of the instrument fit into these holes and any deformation within the 15-in. gage length is multiplied five times by the lever arrangement before being read on the dial attached to the frame. A slight variation is possible in manipulating this instrument and five readings were therefore taken at each observation and averaged. The stress is obtained within a range of less than 1,000 lbs. per sq. in. A regular Berry 6-in. extensometer was used to measure deformations in the concrete over 6-in. gage lengths. These observations are reliable certainly to the nearest 50 lbs. per sq. in. of stress.

Fig. 2 shows the distribution of points at which measurements were made over four of the panels. The numbers given are those used in recording and plotting the data in the subsequent graphs.* The diagram (Fig. 2) is believed to be self-explanatory. The total number of readings was in excess of 3,300. To correct for temperature variations one entire day was spent in observing effects due to temperature alone, and the larger Berry extensometer was read on a standard bar between each series of slab readings. Necessary corrections have been made in the tables accompanying this paper. In general temperature effects were must less serious than were anticipated. In the planning of the tests and the designing of the instruments the writer was assisted by Prof. Arthur N. Talbot and Prof. Herbert F. Moore, of the Engineering Experiment Station of the University of Illinois. It should be noted also, in passing, that the success attending the actual taking of the observations was due in large measure to the fact that all the observers on the test were men of wide testing experience, and thoroughly familiar with the instruments handled. This condition is essential to the successful conduct of such a test. Observations were taken by Professors H. F. Moore and W. A. Slater, and the writer, all of the station staff of investigation. Prof. Talbot was present at the beginning of the test.

*In the original paper the figures of the test are given in tubular form as well as by curves; these curves are omitted from this reprint.—Ed.

The test continued for six days, from Oct. 30 to Nov. 5, inclusive. Eight panels were loaded, as shown in Fig. 1. Readings were first taken on all instruments with the floor unloaded and a load equal to 75 lbs. per sq. ft. was then applied over the entire eight panels. Another set of readings were taken and the load increased to 150 lbs. per sq. ft. In this manner alternate readings and loadings were continued for three days. Overnight readings were taken in the evening, at midnight, and in the morning. The maximum load of 350 lbs. was allowed to remain on floor about 22 hrs., readings being taken at frequent intervals during this time. The floor was then unloaded, the outer panels being first cleared, and finally the load was removed from the center panel. Readings were taken at intervals during the progress of the unloading. The data obtained are plotted in the graphs accompanying this paper. In the limited time since the completion of the test, and under the pressure of other experimentation, it has not been possible for the writer to give the data as thorough study as they merit. A few indications may, however, be pointed out from the graphs.

Observed Data.

DEFLECTIONS.—Figs. 5-6 show graphically the deflections at sixteen points. On the lower line in Fig. 5 note the comparison between readings 5 and 11, where bulkheads existed, and readings 17 and 42, where no bulkheads were present. Other instances of the marked effect of bulkheads on the stiffness of the slab may be seen in the plotted data. We may say also that in general the deflections were greater in the outer panels than in the center panels, due in part to the bulkheads in these outer panels, and in part to the natural tendency to higher stresses and deflections in end panels. The deflections would probably have been smaller with well cured concrete and in considering deflections it must be remembered that this slab was only 43 days old when the maximum load was placed upon it. The maximum deflection found was 0.32-in., exactly 1/1000 of the span. This was at a bulkhead in an outer panel. In the center panel the deflection, for all eight panels loaded, was 0.227-in., or 1/1400 of the span, which increased to 0.274-in., or 1/1200 of the span, when the load was removed from the outer panels.

STRESS IN STEEL AT CENTER.—Figs. 7-8 give the data on the measured deformations in the steel at the center of the spans. The graphs show total deformation over the lengths gaged. On the upper line in Fig. 7 are shown deformations in the center panel and it is to be noted that these are, in general, smaller than those in the outer panels. This would lead us to believe that we should design the steel at the center of the span for one panel loaded, as this apparently gives a worse condition *at the center* than full loading. With reference to Fig. 8 it is of interest to point out that all three of these rods were not as high above the decking as the other rods in the band, and hence took a higher stress than the band as a whole. The embedment of the various rods is given in Table I. The stresses observed at the center were very low and show how marked is the effect of slab action in decreasing the stress at these points.

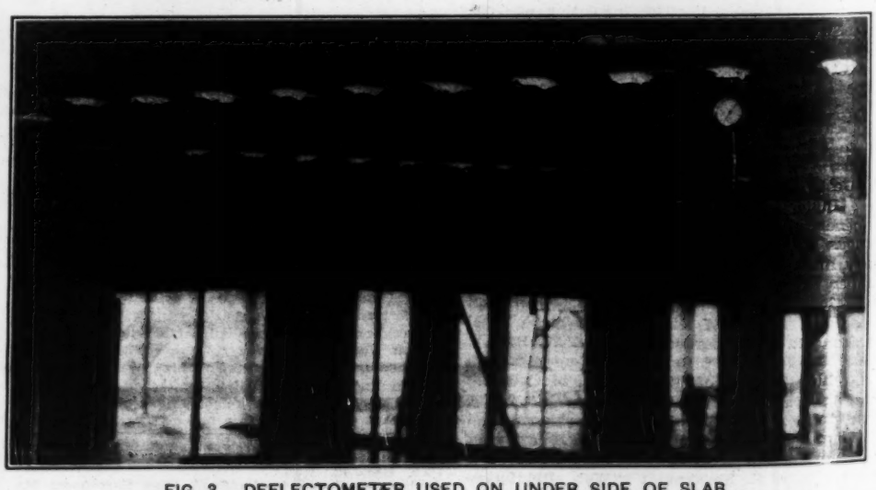


FIG. 3. DEFLECTOMETER USED ON UNDER SIDE OF SLAB.

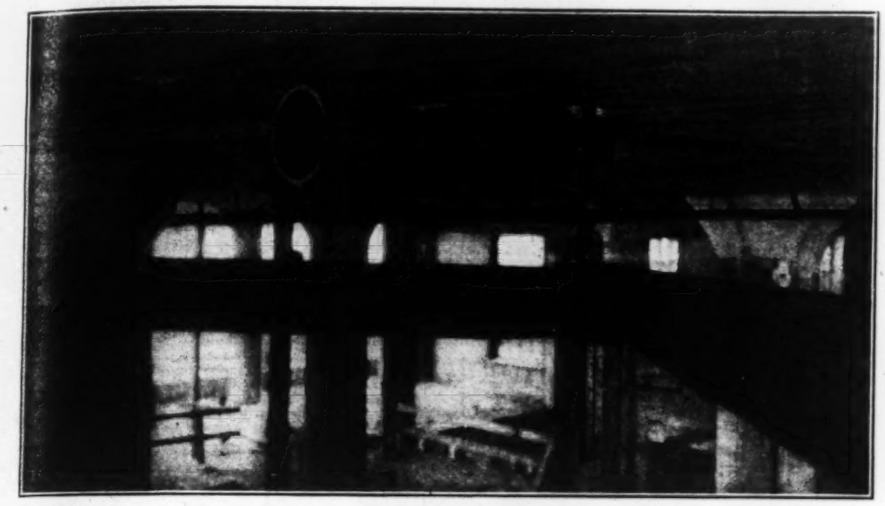


FIG. 4. TWO EXTENSOMETERS USED TO MEASURE DEFORMATION IN STEEL AT CENTER OF SLAB.

It would seem that any attempt to arrive at the values of these stresses without a liberal allowance being made for this slab action must result in misrepresenting the actual conditions. The observed stresses indicate that the diagonal and cross band rods take practically the same stress.

STRESS IN STEEL OVER HEAD.—Fig. 9 gives the data on this subject. The upper row are diagonal rods, the lower row across band rods. Note that rods 205 and 208, which are outer rods in the cross bands, took much higher stresses than rods 206 and 209, which were near the center of the band. In the writer's opinion this is strong evidence against the assertion commonly made that these outer rods serve only to carry load to the rods which they intersect and which do pass over the column. Among the diagonal rods we may note that the stress in rod 207 was measured over the edge of the capital while that in 203 and 204 was measured opposite the center of the column. The higher stress in 207 would seem to indicate that the stress in these rods decreases as we pass from the critical section at the edge of the capital to any section nearer the center of the column. This is as we should expect. The stresses found from these readings indicate clearly that the slab should be designed for a maximum moment over the support, and not at the center as is quite commonly maintained. In the design of this building some 75% more steel was provided over the support than was used at the center, and we easily imagine that the stress must be exceedingly high in many flat slab designs where this extra steel is not provided in anywhere near the same amount. Since the stress reached the allowable value of 16,000 lbs. per sq. in., we may conclude that the designers were not at fault in providing this additional steel over the support.

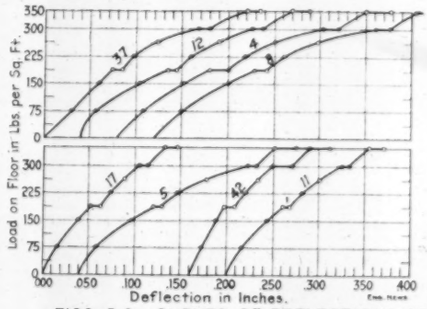
STRESS IN CONCRETE AT EDGE OF CAPITAL.—Fig. 10 gives deformations observed in the concrete. Owing to the fact that no intention of testing existed when the slab was poured no specimens of the concrete were available from which to determine the modulus of elasticity. Hence we are obliged to assume a value for concrete about 40 to 45 days old cured in fall weather at Minneapolis. From experiments made at the University of Illinois concrete of the same age cured under laboratory conditions showed a modulus of 1,875,000 lbs. per sq. in., and in Table II. this value has been used as giving the very highest possible value for the concrete stress. It would probably be fairer to the construction to use a modulus of 1,300,000 lbs. per sq. in., resulting in stresses four-fifths as large. In Fig. 10 a stress of 100 lbs. per sq. in. corresponds to a deformation of 0.0004-in. with a modulus of 1,875,000, or to a deformation of 0.0003-in. with a modulus of 1,500,000.

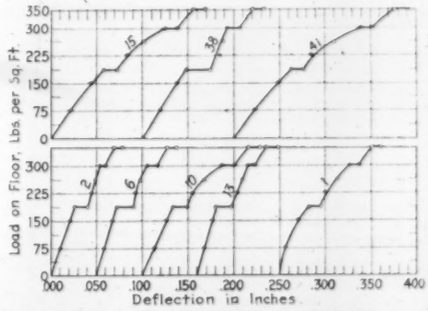
An interesting feature shown in the curves is the falling off in the concrete stress when the load was allowed to remain over night. The decrease is less marked at higher loads than at low loads, while readings taken at very frequent intervals while the maximum load was on the floor showed that at first the stress steadily increased and the decrease did not begin until some time after the load was applied. The phenomenon is of interest as showing the readjustment in stresses which takes place under load even in the least plastic constructions. In general the concrete stresses checked those found in the steel over the support. It would not seem that compressive reinforcement were needed at this point, the maximum stress being from 650 to 750 lbs. per sq. in. which is permissible for concrete stressed in several directions and over a very short distance. If, however, a higher percentage of steel had been used, resulting in a thinner slab, as is commonly done, it is evident that compressive reinforcement would be absolutely necessary for good design.*

SUMMARY OF STRESSES. Table II. gives a summary of the stress found at various points under the design load of 225 lbs. per sq. ft. and also under the maximum load applied of 350 lbs. per sq. ft. In every case where a choice has been possible the higher value has been given, as, for instance, in the concrete stresses the modulus has been assumed as 1,875,000 lbs. per sq. in. instead of the (probably) more just value of 1,500,000 lbs. per sq. in. The dead load stresses have been taken as one-half the live load stress at the design load (the dead weight of the slab being half this load). This, also, is a maximum assumption and probably somewhat in excess of the true value, as the concrete was not broken in tension until after a live load of 75 lbs. per sq. ft. was applied, and the tension in the concrete will undoubtedly account for a much higher percentage of the dead weight than of the live load.

CRACKS.—Very careful observations were taken to discover and record all cracks. A powerful reading glass was used to aid the eye, and dust was removed by means of bellows. It is exceedingly easy *not* to discover cracks in such a test, and an ordinary observer would very likely have been aware of the existence of but few of these cracks. At a load of 262.5 lbs. per sq. ft. a crack was observed at the bulkhead where two days had elapsed between the pouring of the adjacent floor sections. At 300 lbs. per sq. ft. cracks appeared at the other bulkheads. Suggestions of cracks were also found in the center panel where no bulkhead existed and over the edge of the capital at column No. 41, these being very faint and hard to trace for any distance. At 350 lbs. per sq. ft. we were able to trace out the cracks shown in Fig. 11, the dotted lines representing cracks in the ceiling below. The cracks about the column head are of interest as indicating the position of the critical section for which moments should be figured in analyses. These averaged about two or three inches outside the edge of the capital below. At column No. 51 the position of the crack would seem to indicate that for a single panel loaded the critical section moves nearer the support resulting in higher stresses at the center. This crack and similar ones, as at columns No. 49, 39, and 21, were very faint, indicating a lower stress in the steel over the support at such points. The cracks shown running diagonally near columns Nos. 21 and 51 were in all cases directly beneath slab rods. Another set of cracks which developed only under the

*In the slab tested a very low percentage of steel was used, giving a much thicker slab and hence better stress conditions at the support than is usually found in this type of construction. The writer is informed that this is the standard practice of the company which designed the building, but the need of this precaution does not seem to be at all generally recognized.





FIGS. 5-6. CURVES OF DEFLECTIONS OF BOTTOM OF SLAB ARRANGED IN GROUPS OF SIMILAR LOCATIONS.
(See Fig. 2 for Locations.)

TABLE I.—DATA ON POSITION OF RODS ON WHICH DEFORMATIONS WERE MEASURED.

Observation No.	Band.	Position in band.	*Embedment, ins.	Layer of steel over column.
3	Diagonal	Third rod from center	11/16	
7	"	Third rod from center	15/16	
12a	"	Second rod from center	3/4	
14	Cross	Second rod from center	5/16	
14a	"	Outer rod of band	1/2	
39	"	Second rod from center	3/4	
40	"	Outer rod of band	11/16	
108	"	Third rod from center	15/16	
109	"	Outer rod of band	12/16	
110	Diagonal	Third rod from center	3/4	
111	"	Fifth rod from center	13/16	
112	"	Outer rod of band	9/16	
202	"	Outer rod of band	2 3/4	Second layer from top
203	"	Fifth rod from center	2 1/16	" " " "
204	"	Third rod from center	1 3/4	" " " "
207	"	First rod from center	2 3/4	" " " "
205	Cross	Outer rod of band	3 1/4	Third " " "
206	"	Third rod from center	3	" " " "
208	"	Outer rod of band	2 3/4	" " " "
209	"	Third rod from center	2 1/4	" " " "

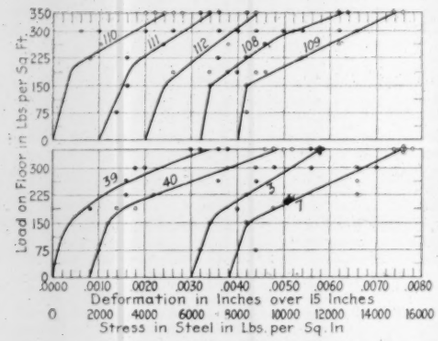
*Measurement from surface to center of rod.

TABLE II.—SUMMARY OF STRESSES.

		Design Load—225 lbs. per sq. ft.			Maximum Load—350 lbs. per sq. ft.		
		L.L.	D.L.	Total.	L.L.	D.L.	Total.
STEEL OVER HEAD:							
Diagonal Band	Maximum	13,800	6,900	20,700	24,200	6,900	31,100
	Average	11,000	5,500	16,500	18,800	5,500	24,300
Cross Band	Maximum	10,000	5,000	15,000	18,800	5,000	23,800
	Average	9,000	4,500	13,500	17,200	4,500	21,700
STEEL AT CENTER:							
Diagonal Band	Maximum	2,400	1,200	3,600	4,800	1,200	6,000
	Average	2,000	1,000	3,000	4,800	1,000	5,800
Cross Band	Maximum	2,800	1,400	4,200	8,000	1,400	9,400
	Average	2,600	1,300	3,800	6,600	1,300	7,900
Outer Panels	Maximum	4,600	2,300	6,900	10,400	2,300	12,700
	Average	3,800	1,900	5,700	8,000	1,900	9,900
CONCRETE AT CAPITAL:							
Diagonal Direction	Maximum	530	263	793	800	263	1,063
	Average	500	250	750	750	250	1,000
Cross Direction	Maximum	500	250	750	800	250	1,050
	Average	468	234	700	750	284	984

Concrete stresses based on E_c = 1,875,000 lbs. per sq. in.

maximum load of 350 lbs. per sq. ft. possesses a peculiar significance. These cracks ran along the center of the cross bands, being easily traced at the center, growing fainter toward the columns, and disappearing entirely in most cases before reaching the crack over the edge of the capital. These cracks afford a most satisfactory evidence of the presence of "slab action," and would be expected to occur if Professor Talbot's theory of such action is accepted. These cracks have, we believe, never been observed before, probably because other building tests have not been extensive enough to develop them to a marked degree, and because cracks have not ordinarily been vary carefully observed.



FIGS. 7-8. CURVES OF DEFORMATIONS OF STEEL AT CENTER OF SPAN.
(See Fig. 2 for Locations.)

General Conclusions.

One test does not permit of very conclusive deductions—we hope and believe that many such tests will be made in the near future, covering a sufficient range of panel sizes and live loads to afford conclusive design data. The most important result of the test, in the writer's opinion, lies in the demonstration that well-equipped laboratories may undertake such tests with the reasonable expectation of securing reliable and useful data. The difficulties to be met are not greater than those encountered in experimental work in the laboratory. It is not believed, however, that inexperienced men would be warranted in undertaking such a test as the instruments used require the handling of trained observers.

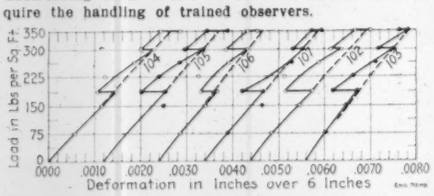


Fig. 10. Curves Showing Deformations of Lower Base of Concrete Slab at Capital.
(See Fig. 2 for Locations.)

The test gives certain well defined indications.

It indicates positively that moments are much greater at the support than at the center of the span.

It indicates, by the position of the cracks, the section for which moments should be calculated at the support.

It indicates that the stresses at the center of the span are much lower than the computed stresses at this point would lead us to expect.

It indicates that bulkheads act to increase deflections and stresses.

The test shows that the design of this particular building is well balanced and that the stresses are safe. It does indicate, however, that serious questions may be entertained as to the stresses in many buildings of this type where higher percentages of steel have been used and very little additional strength provided at the support.

It indicates that the steel *at the center* receives its maximum stress for the condition of one panel only loaded.

BOILER, ELEVATOR AND FLY-WHEEL ACCIDENTS in the United States and Canada in October, 1910, are listed in a circular published recently by the Fidelity & Casualty Co., of New York City. During the month, the number of boiler explosions was 38, in which a total of 24 persons were killed. The most disastrous boiler explosion from the standpoint of fatalities was that at the plant of the American Mfg. Co., in Brooklyn, N. Y., Oct. 20, which was noted briefly in Eng. News, Oct. 27, and in which seven men lost their lives.

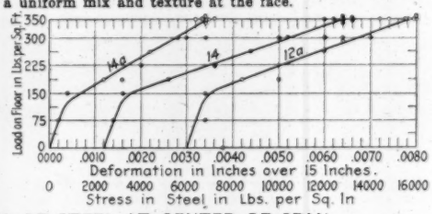
The number of elevator accidents in October was 85 and the number of persons killed was 19. Eight persons were killed by falling down shafts, seven by being caught and crushed, and four by the falling of elevators.

Only four fly-wheel explosions were reported, none of which caused fatal injuries. One of the four "fly-wheels" was an emery wheel and another was an automobile fly-wheel.

Specifications for Scrubbed Concrete Surface.*

For all surfaces of concrete that are to be exposed to view the face forms shall be straight, smooth, evenly matched, and water-tight, and so framed and fastened together at corners and angles with screws or clamps as to be detachable and removable without the necessity of jarring or of prying against the concrete. Any offsets that may appear at joints shall be dressed off flush, and any openings at joints or corners, or any knot holes or other voids, shall be plugged flush with some stiff plastic substance such as clay mixed with plaster of Paris or sand. Before placing the concrete the whole surface of the face form shall be coated with petroleum or other water repellant to prevent adhesion of the concrete.

The concrete shall be thoroughly mixed, be wet enough to flush, and be spaded against the face form to the point of being completely flushed against the form, i. e., until the cement cream or grout follows and envelopes the spade. Then the spade is to be used to ram the concrete near the face so as to push the aggregate of the concrete forward to the face, care being taken to obtain a uniform mix and texture at the face.



The work of placing concrete shall be continuous throughout definite stages so that joints between different days' work shall be at some feature line, or be made truly straight and level.

On the day after placing concrete, or later, as will be determined according to the temperature of the weather and the setting quality of the cement used, while the concrete is friable or pulverable the forms shall be carefully removed and the concrete surface immediately scrubbed until the surface film is removed and the aggregate is exposed to a uniform degree, and then rinsed off with water and kept moist for several days. If any void spaces appear, or if spalls are broken off, the defects shall be patched with similar mix immediately after the scrubbing, using the hand or a wooden float—not a steel trowel—for applying and smoothing the patches. After they are sufficiently set—say within from five to twenty-four hours—all patches must be scrubbed to the same texture as the general surface and be rinsed clean and kept moist for several days.

If a granolithic surface is specified it shall be made by placing against the face forms in advance of the body concrete a fine granolithic or facing concrete composed of 1 part Portland cement, 1½ parts sand and 2½ parts pebbles or crushed granite or other approved stone as may be selected, screened to pass a ½-in. and be retained on a ¼-in. screen, thoroughly mixed and soft enough for full flushing. This granolithic must be maintained between the body concrete and the face form in a thickness of about 1 in., care being taken that the body concrete is rammed into and perfectly united with it. If iron or wooden moldboards are used to retain the granolithic against the face while placing the body concrete care must be taken that the board is not permitted to remain until initial set takes place, but be frequently jarred and raised slightly at short intervals to prevent the formation of shuts and seams and air spaces between granolithic and concrete.

For scrubbing the surface, ordinary fiber brushes with a light stream of water from hose or can will be sufficient if the set is not too hard. If set is harder, wire brushes followed by fiber brushes and rinsing, may be used.

If for any reason a portion of the face form cannot be or fails to be removed before the concrete has become too hard for removing the surface film by scrubbing, the hard face shall be treated by sand-blasting or tool-dressing to a texture matching the scrubbed portion. If it be tool-dressed it shall be cleaned after tooling by washing it with a 1 to 10 solution of muriatic acid and water, then thoroughly rinsing with water to remove all traces of the acid.

In scrubbing, or sand-blasting, or tool-dressing, care must always be taken to avoid roughening or blunting corners of the work, and to maintain all edges sharp.

*Presented by Mr. H. H. Quimby, M. Am. Soc. C. E., Assistant Engineer of Bridges, Bureau of Surveys of Philadelphia, Pa., to the Annual Convention of the National Association of Cement Users, New York City, Dec. 10, 1910, and sent by that Convention to a letter ballot of the Association to be adopted as a standard of the Association.

DIRECT OR CITY LABOR AT NORWICH, ENGLAND, has been found unsatisfactory by Mr. E. A. [illegible], M. Inst. C. E., City Engineer, as is expressed in the following statement, given in the London "Surveyor" [illegible] v. 25.

My reason for recommending the Executive [illegible] to carry out the proposed convenience near [illegible] Gates by contract instead of direct labor is [illegible] execution of general building works during the past eighteen months or two years I have been led to the conclusion that much of the extra labor [illegible] me, or on my behalf, is not satisfactory. The [illegible] not as expeditious as should be the case; there [illegible] tendency for them to regard the Corporation as [illegible] "bottomless purse," and to consider there is [illegible] necessity for them to exert themselves. My [illegible] of action in dealing with employees is not the same as that of a contractor. It is not uncommon for my action to be called in question by members of the Council for discharging men with whom I am not satisfied, and while the evidence upon which I have acted would be considered quite sufficient by a contractor in dispensing with the services of men, yet in my case it might not be sufficient to enable me to answer the very numerous detail questions often put to me. There are a large number of men who may be described as in the regular employ of the Corporation, many of them having been selected out from time to time as the most satisfactory of those casually employed; these men can be relied upon to earn their wages and often a bit more. This enables me to carry out the regular work of the Corporation with generally satisfactory results, but it is when a sudden expansion of staff is necessitated by some special work, generally of a building character, that I have difficulties in getting works carried out to my own satisfaction as regards cost of labor.

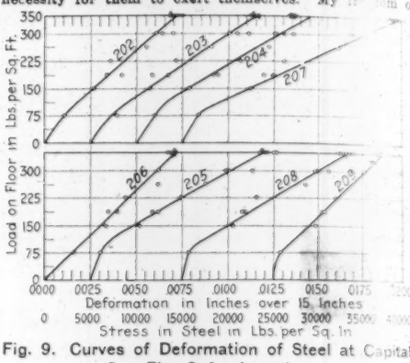


Fig. 9. Curves of Deformation of Steel at Capital.
(See Fig. 2 for Locations.)

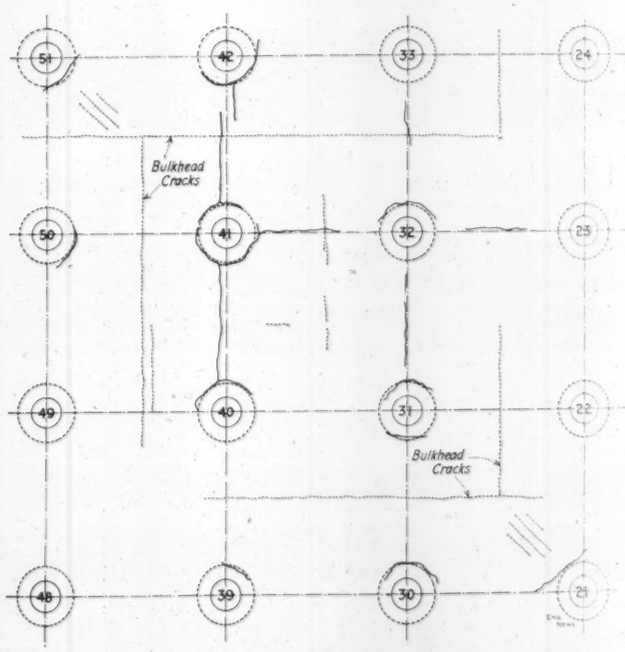


FIG. 11. PLAN OF FLOOR AFTER TEST SHOWING CRACKS.

In accordance with Mr. Collins' recommendation the city authorities reversed their "general policy" and invited bids for the work. The incident has particular interest because of the strong hold which the direct-labor system has gained in England.

A CITY PUMPING STATION BURNED, Dec. 8, at Fort Worth, Tex. This was the Powell Pumping Station, four miles west of the city on Clear Fork. The fire has temporarily cut off the supply from ten of the city's artesian wells, which have been depended upon for about half the water-supply for domestic purposes in Fort Worth.

TWO COAL MINE ACCIDENTS were reported last week. An explosion in the mine of the Bond Coal Co. at Greyco, near Coeburn, Wise Co., Va., Dec. 14, killed ten men. Two men were rescued alive after remaining in the mine for 20 hours after the explosion. They were kept alive by air from a pipe communicating with the surface.

A fire started in one of the two shafts of the Leyden Coal Co.'s mine at Leyden, Colo., Dec. 15. Twelve men at a 750-ft. level were unable to reach the shaft before the flames had cut off their escape. Rescue parties have not yet been able to enter the mine.

THE GERMAN STEAMER "PALERMO" was wrecked off Cape Corrubodo on the west coast of Galicia, Spain, Dec. 15. The 24 persons on board were drowned. The "Palermo" was a freight and passenger vessel of 686 tons.

The Swedish steamer "Cedric" was wrecked last week off the Swedish coast and twelve persons were drowned. The "Cedric" was of about 1,100 tons displacement and was loaded with coal.

THE BRITISH NAVAL TENDER "ELFIN" was sunk, Dec. 16, in a collision with a submarine, near Harwich, England. Five of the "Elfin's" crew were drowned.

AN EXPLOSION IN THE COAL BUNKERS of the U. S. Battleship "North Dakota" was reported from Cherbourg, France, Dec. 14. One seaman was killed.

A DISASTROUS EXPLOSION wrecked a storage battery-house in the Grand Central Terminal yard of the New York Central & Hudson River R. R. on the morning of Dec. 19, killing ten persons and injuring over 100. The house was on the southwest corner of 50th St. and Lexington Ave. The easterly part of the house was destroyed, a street-car passing in Lexington Ave. was wrecked and overturned on an automobile truck, houses on the opposite sides of Lexington Ave. and 50th St. were partly shattered, and minor damage was done over an area within a quarter-mile radius of the spot. A large power-house of the New York Central just southwest of the site of the explosion was not injured. Official statements up to the present unite in charging the accident to an explosion of Pintsch car-lighting gas which escaped from a broken pipe and filled the open basement story of the battery-house. The following statement summarizes briefly what has been reported of the official investigations to date.

The battery-house, two stories high, extended along 50th St. west from Lexington Ave., and was 30 to 40 ft. deep to the south. The ground floor was occupied as a carpenter shop, the upper floor as a storage-battery room. The depressed yards of the New York Central extend to this point and include the area under the building. Thus the space below the ground floor of the house was entirely open on the southerly side, facing the yard. Storage tracks running north and south ended at bumping posts about at the south line of the building. While standing on these tracks, cars are charged with Pintsch gas. A gas storage and distributing station is located about 500 ft. to the south, and here the gas is received by tank cars from the Mott Haven yard and is transferred to storage tanks. Pipes lead through the yard from the storage station. One of these pipes, together with air and steam pipes, passed along in the space under the battery-house. About 8 a. m., Dec. 19, when a cut of cars was being backed down to the bumping-posts, the motorman could not stop it in time (through getting no sand from his sand-box, he claims), and the train broke through the bumping-post. Debris or stored material struck by the train broke the near-by pipe carrying Pintsch gas, and during the next half-hour a large volume of gas escaped from the break. It is reported that the storage-station attendant, judging from the reading of the pressure-gage, testified that about 14,000 cu. ft. of gas escaped. Apparently the gas was not cut off from the yard pipes until just before the explosion. About half an hour after the bumping-post collision a violent explosion occurred in or about the battery-house, with the results above stated. The north wall of the house was thrown down into 50th St., the upper half of the east wall was blown down, and the floors and roof and roof-trusses fell, the latter hanging from the south wall, which remained largely intact.

The theory held by the authorities is that the gas accumulated in the space under the battery-house and exploded there, although this space was open on its southerly long side and the gas (being considerably lighter than air) was free to escape at this side. This theory does not clearly account for the violence of the explosion or the distribution of damage. Little damage was done immediately in front of the open face of the basement space, and practically no flame effects are reported from here. The gas storage station and a dynamite magazine south of it were not injured. Early rumors were to the effect that some dynamite was stored in the battery-house, but this has been denied by one of the executive officers of the railway. The surmise has been advanced that hydrogen evolved from the storage batteries accumulated in the battery-room and exploded, but this is only a surmise.

The District Attorney of New York County is investigating the case. The Municipal Explosives Commission, a body auxiliary to the Fire Department, is investigating independently. The Coroner's office is also at work. The railway company is understood to be looking into the matter thoroughly and has promised to make public the results of its inquiry.

PENNSYLVANIA RAILWAY ACCIDENT STATISTICS give the number of persons killed on the steam roads in that state in the month of October as 72. In addition, 17 persons were killed on the electric lines. Of those killed on the railroads, 31 were trespassers.

THE ADDITIONS TO RAPID TRANSIT SUBWAYS in New York City will probably be built by the Interborough Rapid Transit Co., in accordance with its offer to the Public Service Commisson on Dec. 5. The offer of the Hudson Companies through Mr. Wm. G. McAdoo, its President, was withdrawn on Dec. 15. The offer of the Interborough Co. is to construct extensions of the present subway system involving a total expenditure of $128,000,000, and additional tracks and extensions to the Manhattan Elevated system, involving a total outlay of about $32,000,000. The City of New York will contribute about $53,000,000 of this amount and the rest will be raised by the Interborough Co.

The Public Service Commission on Dec. 20 advised the Board of Estimate and Apportionment of its belief that the acceptance of the Interborough offer instead of constructing the Triborough system, for which bids were received last month, would be for the best interests of the city.

PRIZES IN THE ECONOMIC ESSAY CONTESTS, annually provided for by Hart, Schaffner & Marx, of Chicago, have been announced for 1910. The first prize ($600) in Class A was for a paper on "The Navigable Rhine," submitted by Edwin J. Clapp, Instructor of Political Economy in Yale University. The first prize ($300) in Class B was awarded to J. F. Strombeck, undergraduate in Northwestern University. Subjects for the prize essay contests of 1911 may be obtained by addressing J. Laurence Laughlin, Box 172 Faculty Building, University of Chicago.

A SEWAGE-SLUDGE DISPOSAL SUGGESTION.—The usual practice in the past has been to provide every possible means of preventing solids from passing on to filters or contact beds, as it was generally found that these tended to clog the filter material. It is now largely recognized that, however small the quantity of solids in suspension in a tank effluent supplied to a filter may be, the filter effluent still contains a considerable amount of solids in suspension, with the result that it has to be settled out in what are known as humus pits or effluent settling tanks, which are now being applied in some form in nearly all schemes, even after contact beds. Some time ago the author was compelled by force of circumstances to recognize this fact, and he has gradually come to the conclusion that the most satisfactory method to adopt is not to try and arrest the suspended solids on the surface of the material or in the filters, but to allow it to pass into the interstices of the material and provide every possible facility for it to get away freely in the effluent. This applies both to contact beds and percolating filters, and involves the use of material of a uniform grade from the surface down to within 6 ins. or 9 ins. of the floor, a bottom layer of a larger grade and a complete false bottom, with properly designed apertures over the whole area of the floor. In a paper read before the Society of Engineers in March, 1910, the author recommended the use of a complete false floor for all contact beds, but found very few to agree with him. He still believes, however, that this is the best method to adopt; and now suggests that the principle of allowing the solids to be broken down and decomposed as far as possible in each stage of the process, and then to pass out freely with the effluent to the next stage of purification will not only prevent the sludging up of tanks and the clogging of filters and contact beds, but will also reduce very considerably the quantity of solids left to be disposed of separately. This reduced quantity will, further, be delivered in a condition in which it can easily be air-dried on properly constructed draining beds without causing any nuisance, and thus in many cases help to minimize the difficulties of the sludge problem. From a paper by W. C. Easdale, on "The Sludge Problem," before the annual meeting of the (British) Association of Managers of Sewage Disposal Work, Dec. 8, 1910. The complete paper appeared in the London "Surveyor," Dec. 9, 1910.

THE LATEST PHASES OF SEWAGE PURIFICATION.—To make a final recapitulation, we have seen the advisability of separately considering the questions of preventing the transmission of diseases and preventing a nuisance. We have also seen that each question should be independently treated in a manner most suitable to accomplish effective and economical results.

Disease bacteria will gradually perish if surrounded by conditions antagonistic to their life, or they will be quickly destroyed by disinfectants. The conditions and necessities of each case will indicate the most practicable means of their elimination.

The nuisance to sight at a sewage outfall can be prevented by proper devices to hold back and remove the floating matter before it is exposed.

The nuisance to smell in a sewer can be prevented by a rapid and complete removal of both liquid and solid matters and by ample ventilation, all of which tends to keep the sewage fresh.

The nuisance to smell at points of delivery and disposal can be prevented:

(1) By an immediate submerged discharge into flowing water with suitable dispersion and sufficient dilution.

(2) By a separation of the liquids from the suspended sludge-forming matter, so far as practicable while the sewage is still fresh.

(3) By an oxidation of the liquids with the aid of a sufficient quantity of fresh air in well-designed and operated filters, whether intermittent sand or coarse-grained filters.

(4) By a natural defecation of the sludge in such a way that no offensive gases are produced.

Experience has been ample to indicate that each of these requirements can be fulfilled in practice, when ordinary care, intelligence and skill are devoted thereto. It therefore seems that during the last few years we have at last reached the point where the art of sewage purification has found a rational and practicable basis, and where the process can be effected without a nuisance.—Concluding summary of presidential address by Rudolph Hering, M. Am. Soc. C. E., before the New Jersey Sanitary Association, Lakewood, N. J., Dec. 2, 1910.

NEW YORK CITY CANNOT INTERVENE in the Passaic Valley sewage disposal suit brought some time ago by the State of New York against the Passaic Valley Sewerage Commission. It will be remembered that the United States sought and was granted permission to intervene in the suit, but that subsequently a compromise was effected and the intervention suit withdrawn (Eng. News, May 12, 1910). During the past summer the Metropolitan Sewerage Commission of New York urged the New York City authorities (1) to attempt intervention, in case New York State did not also compromise and withdraw its suit, and (2) to bring an independent suit in case the suit was withdrawn. A few weeks ago Mr. Archibald Watson, Corporation Counsel of New York City, notified Mr. Hugh Gordon Miller (220 Broadway, New York City), Special Assistant to U. S. Attorney-General Wickersham, of a motion and petition to intervene in the U. S. Supreme Court. The result was the denial announced. What this journal considered to be the weakness and folly of the recommendation of the Metropolitan Sewerage Commission was expressed editorially in our issue of June 9, 1910.

THE RETURN OF CEMENT BAGS FROM THE PANAMA CANAL.—(From the "Canal Record," Dec. 7.) About 90% of the bags in which cement is shipped to the Isthmus for use in the Pacific Division locks are saved and returned to the manufacturers, who allow 8½ cts. apiece for them. The cement is shipped in a bag enclosed within another bag, both made from material of the same grade and weight, the allowance to each bag of cement, therefore, representing 17 cts. As fast as the bags of cement are emptied at the mixers they are loaded into box cars and carried to a building, where they are sorted and baled. From 20 to 30 men, under a white foreman, are constantly employed in the sorting shed, and at the present time, a day's work in sorting and preparing for shipment represents from 25,000 to 35,000 sacks. The good bags are packed in bales of 100 each, and the torn or otherwise damaged bags, in bales of 50 each. The damaged bags are mainly utilized by filling them with sand for the construction of dikes.

The bags are shaken before they are placed in the baling press, and 50, or more, barrels of cement a day is secured. This cement is in good condition; is used in concrete operations in the locks, and the value of it pays the wages of the force employed at the sorting shed, including the foreman. Many of the bags sent to the States months ago are now returning filled the second time, and are still whole, capable of being used again. A statement of the number of good bags returned to the manufacturers from the beginning of concrete operations at the Pedro Miguel and Miraflores Locks, and the value thereof, is shown in the following table:

Month.	No. of bags.	Value.
To April 25, 1910	740,000	$82,900
May	180,000	15,300
June	180,020	15,353
July	182,516	15,513
August	120,016	10,201
September	540,392	45,950
October	600,000	51,000
November	661,366	56,210
Total	3,205,050	$272,429

Personals.

Mr. W. L. Mattoon, formerly Assistant Engineer of the Hocking Valley Ry., has been appointed Real Estate Agent in charge of Taxes for the same company.

Dr. George E. Vincent, Dean of the Colleges of Arts, Literature and Science, of the University of Chicago, has been elected President of the University of Minnesota, to succeed Dr. Cyrus Northrop, who has resigned

Prof. B. H. Meyer, of the University of Wisconsin, Chairman of the Wisconsin Railroad Commission and Mr. C. C. McChord, of Kentucky, have been nominated by President Taft to be members of the Interstate Commerce Commission.

Mr. J. G. Bower, Assoc. Am. Soc. M. E., has been appointed Assistant Manager of Sales, Western District, for the Pressed Steel Car Co. and the Western Steel Car & Foundry Co., with offices in Old Colony Bldg., Chicago, Ill.

Mr. A. B. Alderson, Assoc. M. Am. Soc. C. E., for the past 12 years Town Engineer of West Hartford, Conn., has established an office for general engineering practice in Hartford, Conn. He will make a specialty of town engineering and highway work.

Mr. Edward H. Cowan, a civil engineer, formerly General Manager of the France Dredging & Construction Co., of Mansfield, Ohio, has opened an office for private practice at Taylorville, Ill. He will make a specialty of work in connection with court actions and for contractors.

Mr. J. W. Kendrick, M. Am. Soc. C. E., Vice-President in charge of operation of the Atchison, Topeka & Santa Fe Ry., has been granted a six-months' leave of absence, during which he will make a tour of the world. Mr. W. B. Story, M. Am. Soc. C. E., Vice-President in charge of construction, will assume Mr. Kendrick's duties during his absence.

Mr. A. W. Thompson, M. Am. Soc. C. E., Chief Engineer of the Baltimore & Ohio R. R., has been appointed General Manager. Mr. Thompson had but recently been promoted from Engineer of Maintenance-of-Way to Chief Engineer. He entered the service of the Pittsburg & Lake Erie R. R. as a rodman in 1898. He has been with the Baltimore & Ohio R. R. since 1899, and has held successively the positions of Transitman, Assistant Division Engineer, Division Engineer, Division Superintendent and Engineer of Maintenance-of-Way. He graduated from Allegheny College, Pennsylvania, in 1897.

Obituary.

Matthew Kennedy, Treasurer of the Kennedy Valve Mfg. Co., of Elmira, N. Y., died on Nov. 26.

William Cleburne, a surveyor on the Union Pacific R. R. in its earliest times, died in Newport, Ky., on Dec. 14, at the age of 86 years. He was a brother of Gen. Patrick Cleburne of the Confederate Army.

John Fletcher Hanson, President of the Central of Georgia R. R., and of the Ocean Steamship Co., of Savannah, Ga., died at his home in Macon on Dec. 16. He was born in Georgia in 1840, and was educated in the public schools. He served throughout the Civil War in the Confederate Army, and retired at its close as a Major. His railroad career did not begin until 1894 when he became a director of the Georgia Southern & Florida R. R. He became a director of the Central of Georgia R. R. in 1895, and President in 1903.

Through the courtesy of two prominent engineers, who were at different periods intimately associated with the late Benjamin Silliman Church, whose death was noted in this place last week, we are able to print the following additional facts.

Benjamin Silliman Church commenced his profesional career in 1852 on the construction of the second track of the New York & New Haven R. R., and then entered Dartmouth College, where he graduated in 1856 with the degree of C. E., receiving later the degree of M. S. from this institution.

In 1857 and 1858 Mr. Church was one of the assistant engineers on the topographical survey of the Croton watershed, which was made with a view of locating the best sites for storage reservoirs for the water supply of the City of New York. In the latter part of 1858 he was transferred to the construction of the new receiving reservoir in Central Park, New York City, which has a capacity of 1,016,000,000 gallons.

In 1859 Mr. Church was appointed Resident Engineer in charge of the old Croton aqueduct, the Croton reservoirs, and the pipe system of the city. He continued in this position until 1880, with the exception of one or two years in the beginning of the Civil War, when he served in the Army of the Potomac as Captain of Engineers. Mr. Church went to the front in 1861 with the 12th Regiment of New York Militia, and was later transferred to the staff of General Barnard, Chief Engineer of the Army of the Potomac. His principal duties consisted in making topographical maps in Virginia. After being disabled in the war, he returned to his position as Resident Engineer on the Croton Water Works.

Later he was made Colonel of Engineers on the staff of Hon. David B. Hill, Governor of the State of New York., and was known thereafter as Colonel Church.

During the long period that Mr. Church was connected with the Croton Water Works, he had an excellent opportunity of studying the weak points in the construction of the old Croton Aqueduct, and to investigate plans for increasing the city's water supply. As early as 1868 he planned the construction of a great masonry dam across the valley of the Croton River, about four miles below the old Croton Dam, built in 1836-1842, whereby a large storage reservoir would be formed and 115 square miles added to the available watershed supplying the city.

In 1880 Mr. Church was made Consulting Engineer of the Department of Public Works, and in this capacity he assisted the late E. S. Chesbrough in preparing plans for a storage reservoir of 30,000 million gallons capacity in the Croton watershed, and of a new aqueduct from this reservoir to the City of New York. The reservoir was to be formed by a huge masonry dam, about 275 ft. high above the foundation, which was to be built across the Croton River near the old Quaker Bridge, about four miles below the old Croton Dam. From its location the proposed structure took the name of the Quaker Bridge Dam.

The legislature of 1883 passed an act authorizing the construction of the proposed new works, and entrusted the execution to a special commission known as the Aqueduct Commission. Mr. Church was appointed Chief Engineer of this Commission in 1883, and held this position until Nov. 21, 1888, when he resigned as Chief Engineer and was made the Consulting Engineer of the Aqueduct Commission. On Aug. 1, 1889, this position was abolished, and Mr. Church retired from the service of the City of New York, in which he had been without interruption, excepting while with the Army of the Potomac, for about 33 years.

While Chief Engineer of the Aqueduct Commission, Mr. Church had not only to attend to the engineering features of the work, but had to undergo an unusual amount of mental strain and worry in trying to resist the many unwarranted claims of the contractors, to which the Aqueduct Commissioners were only too prone to listen. In 1888 a joint committee of the legislature, known as the Fassett Committee, investigated the affairs of the Aqueduct Commission. This led to the abolition of this Commission and to the appointment of a new Board of Aqueduct Commissioners by Mayor Hewitt. The new Commissioners made an excellent record, and their Chief Engineer, the late Alphonse Fteley, was sure of their support, which made his position much easier than that of his predecessor.

After leaving the service of the City of New York, Mr. Church did a general engineering business as consulting engineer, his advice being sought about various proposals for water-works and water-power prospects both in Canada and the United States.

In 1897 he became interested in the design of steam turbines, and had continued to work in this field intermittently up to the time of his death.

Colonel Church had a mind of wonderful grasp both for mechanics and mathematics. His endeavor was to produce a steam turbine which, while retaining all the characteristics of flow and relative velocities of the water turbine, would provide for the expansive flow of the steam and also have a perfect balance of force due both to steam pressure and mechanical stresses when in operation.

The sudden death in 1900 of a financier who had arranged to exploit the invention prevented the commercial development of the turbines designed by Mr. Church.

Aside from his work as a hydraulic engineer, Mr. Church was the inventor of a water meter, a pedometer, and a waste water detector. The last mentioned invention had considerable merit, but Mr. Church found difficulty in introducing it, as he did not possess the necessary means.

Mr. Church became a member of the American Society of Civil Engineers in 1867, but withdrew from the Society some years ago.

Engineering Societies.

COMING MEETINGS.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 27. Annual meeting at St. Paul, Minn. Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 27-28. Annual meeting at Lafayette, Ind. Secy., E. W. Hamilton, Iowa State College, Ames, Iowa.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 2-6. Annual meeting at Winnipeg, Man. Secy., C. H. McLeod, 413 West Dorchester St., Montreal, Que.

INDIANA ENGINEERING SOCIETY.
Jan. 12-14. Annual meeting at Indianapolis, Ind. Secy., Charles Brossmann, Indianapolis, Ind.

MONTANA SOCIETY OF ENGINEERS.
Jan. 12-14. Annual meeting at Helena, Mont. Secy., Clinton H. Moore, Leyson Block, Butte, Mont.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 17. Annual meeting at Pittsburg, Pa. Secy., Elmer K. Hiles, 803 Fulton Bldg., Pittsburg, Pa.

AMERICAN INSTITUTE OF ARCHITECTS.
Jan. 17-19. Annual convention at San Francisco, Cal. Secy., Glenn Brown, the Octagon, Washington, D. C.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 18-19. Annual meeting at New York City. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

ILLUMINATING ENGINEERING SOCIETY.
Jan. 20. Annual meeting at New York City. Secy., P. S. Millar, 29 West 39th St., New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 24-26. Annual meeting at New York City. Secy., W. M. Mackay, P. O. Box 1818, New York City.

OHIO ENGINEERING SOCIETY.
Jan. 24-26. Annual meeting at Columbus, O. Secy., C. J. Knisely, New Philadelphia, Ohio.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 23-27. Annual meeting at East St. Louis, Ill. Secy., E. E. R. Tratman, 1636 Monadnock Block, Chicago, Ill.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Feb. 6-11. Annual convention at Louisville, Ky. Secy., T. A. Randall, Indianapolis, Ind.

ORGANIZATION OF CITY OFFICIALS FOR STANDARDIZING PAVING SPECIFICATIONS.—The second annual meeting will be held at the Astor Hotel, New York, Jan. 10 to 14. The organization represents 30 American cities. The work outlined at the meeting held in Chicago in February, 1910, has been perfected by the various committees, and it is expected that final reports for complete specifications will be adopted. The Secretary is John B. Hittell, City Hall, Chicago. (His address after Jan. 4 will be at the Astor Hotel, New York.)

BROOKLYN ENGINEERS CLUB.—At the 14th annual dinner, Dec. 15, Dr. Rossiter W. Raymond gave an address on the "Panama Canal." He laid especial emphasis on the work of Col. Gorgas, Chief of Sanitation, as a factor in the success of the canal. Dr. Alex. C. Humphreys followed with an address on "Engineering Education: The Concrete Rather Than the Abstract." The other speaker of the evening was Mr. John F. O'Rourke. Mr. Wm. G. McAdoo, who had been expected to speak, was unable to attend on account of illness.

The election of officers for the ensuing year was announced as follows: President, Winfred H. Roberts; Vice-President, John M. Steinmetz; Secretary, Joseph Strachan; Treasurer, Wm. T. Donnelly.

LAKE MICHIGAN WATER COMMISSION.—This commission is composed of representatives of states and municipalities fronting upon Lake Michigan, and its object is to secure united action for the protection of the lake from pollution. Its eighth meeting was held at the 39th St. pumping station of the Sanitary District of Chicago, on Dec. 17, with Dr. W. A. Evans, Health Commissioner of Chicago, in the chair. A paper on "The Sanitary Condition of the Calumet River in Indiana" was read by Mr. J. H. Brewster, Chemist of the Indiana State Board of Health. This was followed by a paper on "The Disposal of Starch Factory Wastes," by Mr. T. B. Wagner, and Mr. O. H. Sjostrom, of the Corn Products Refining Co. The process used at the company's plant at Waukegan is a combination of precipitation and sedimentation, but as yet no commercial use has been discovered for the sludge, which is accumulating in large quantities.

The experimental sewage purification plant at the pumping station was described by Mr. Langdon Pearse and Dr. Arthur Lederer, of the Sanitary District. The plant was inspected by the visitors. At the business session, Dr. George B. Young, U. S. Marine Hospital Service, Chicago, was elected President. Dr. E. Bartow, Director of the Illinois State Water Survey, Urbana, Ill., was re-elected Secretary.

INDIANA GOOD ROADS ASSOCIATION.—In compliance with recommendations made at the recent annual National Good Roads Convention held in Indianapolis, a committee composed of two members each of the several engineering and improvement societies of Indiana held a meeting Dec. 17 in the Board of Trade Bldg., organized the Indiana Good Roads Association and elected the following officers: President, Clarence Kenyon, Indianapolis; Vice-Presidents, Carl G. Fisher, Indianapolis; John E. Lamb, Terre Haute; S. P. Stratton, Richmond; L. Ert. Slack, Franklin; M. R. Sultzer, Madison, and A. M. Beardsley, Elkhart; Secretary-Treasurer, W. J. Dobyns, Board of Trade Bldg., Indianapolis.

Mr. Kenyon thanked the members and proceeded to appoint the following legislative committee: Henry W. Klausman, B. J. T. Jeup, Charles W. Brossman, Charles C. Brown, Wm. H. Dye, James W. Noel, Wm. P. Blair, Fred. I. Willis, C. Kenyon, David Wallace, J. C. Crabill, Wm. F. Elliott, B. B. Korbly, C. A. Carlisle, Wm. Fortune and C. G. Fisher, of Indianapolis; L. E. Slack, of Franklin; W. D. Brandt, Brookville; W. L. Slinkard, Bloomfield; John O. Pattes, Muncie; Morton H. Downey, Anderson; Prof. W. K. Hatt, Lafayette; Horace Stillwell, Anderson; and H. C. Pittinger, Muncie. This committee was directed to draft a bill embracing three or more important provisions. First, it will provide for a State Highway Commission and state aid in the construction and maintenance of Indiana's principal roads; secondly, provision will be made for a graduated vehicle and automobile tax annually; and thirdly, it will provide for the use of convict labor in the preparation of road material and on the actual construction and maintenance of roads. Other provisions may be added after consultation with Governor Marshall.

President Kenyon said that out of the thousands of answers received from persons asked for an opinion concerning the advisability of enacting a highway commission law containing the above provisions, 95% answered favorably, but a number opposed the use of convict labor on the roads.